FY13 Specialty Crop Block Grant Program- Farm Bill

North Dakota Department of Agriculture

Final Performance Report
USDA Agreement # 12-25-B-1689

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Final Report

Partner Organization: National Sunflower Association

Project Summary

Downy mildew (DM), cited by *Plasmopara halstedii*, is an important cause of yield loss in sunflower. The disease can cause heavy losses of up to 50-95% in cool wet years and adversely affects other aspects of seed quality. The best way to control this disease is to use sunflower hybrids with resistance to the disease. Unfortunately, no DM resistant germplasm and commercial hybrid are available in confection sunflower. The objectives of this proposed project are 1) incorporation of DM resistance identified in oil-type sunflower into confection sunflower, 2) molecular mapping of DM resistance genes, and 3) pyramiding DM and rust resistance genes in a single genetic background. The confection germplasms with DM resistance combined with rust resistance will be provided to the private seed industry for incorporation into finished hybrids. Resistance to both DM and rust, two severe diseases in sunflower, is an important agronomic factor in keeping U.S. confection sunflower competitive. This is a three-year project to transfer DM resistance genes from oil-type sunflower into confection sunflower because it needs eight generations of cross and backcrosses to complete this process. In the year-first, we completed one cross and two backcrosses, and developed SNP markers linked to downy mildew resistance gene Pl_{17}.

Project Approach

I. Crosses were made between CONFSCLR5/RHA 464 (carrying Pl_{ARG} and R_{12}), HA-R6 (R_{13a})/HA 458 (Pl_{17}), and HA-R6 (R_{13a})/HA-DM1 (Pl_{18}) in January 2014. The obtained F_1s were tested using downy mildew race 734 and were grown in the greenhouse. The backcrosses of F_1 hybrids to the recurrent parents were made to produce BC_1 in the early June, 2014. Recurrent backcrossing to CONFSCLR5 and HA-R6 was repeated and the BC_2 generation was obtained in late of March 2015.

II. The downy mildew resistance gene in HA 458 was mapped to linkage group 4 of the sunflower genome and named as Pl_{17}. A total of 41 SNP markers were selected and used to saturate the Pl_{17} region, and two SNP markers were found to be closely linked to Pl_{17}.

III. Molecular mapping of DM R gene in RHA 468 is in progress. One hundred and ninety F_2-derived F_3 families (30 seedlings from each of F_3 family, total 5,700 seedlings) were inoculated with DM race 734 and recorded for performance. Bulked segregant analysis located the DM R-gene to linkage group 1 of the sunflower genome. Genomic DNA was isolated for 183 F_2 individuals and parents, and genotyping of F_2 population with polymorphic SSR and SNP markers is underway.

IV. A postdoctoral research associate, Dr. Guojia Ma, was hired by North Dakota State University (NDSU) and started to work on the project on March 1, 2014. An undergraduate Research Assistant, Jared Helstad, was hired by NDSU and started to work on the project on Feb. 9, 2015.

Goals and Outcomes Achieved

The goals for 2014

a. Create the first cross in greenhouse in January and backcross (BC_1) in the summer field and BC_2 generation in the winter greenhouse
b. Test all generations in laboratory/greenhouse for resistance
c. Saturation mapping of DM resistance gene in HA 458 with SNP markers
d. Begin the process of identifying molecular markers for the resistance gene derived from *H. argophyllus*

Outcomes achieved

I. Cross and backcross

1. Crosses were made between CONFSCLR5/RHA 464, HA-R6/HA 458, and HA-R6/ HA-DM1 in January 2014. CONFSCLR5 and HA-R6 were used as 'recurrent' parents, whereas RHA 464, HA 458, and HA-DM1 as DM resistant donors, which are resistant to all known DM races identified so far.
2. The obtained F_1s were tested using downy mildew race 734. Two F_1 hybrids derived from the crosses of HA-R6 with two DM resistant lines, HA 458 and HA-DM1, were backcrossed to the recurrent parent HA-R6, and the F_1 hybrid derived from the cross of CONFSCLR5 and RHA 464 was backcrossed to CONFSCLR5. BC_1 seeds were harvested in August, 2014.
3. A total of 100 BC_1 seeds from the cross of HA-R6/HA 458 were germinated. Of them, 35 seeds with suitable length of root tip were inoculated with DM race 734. Eight resistance plants were selected and backcrossed to the recurrent parent HA-R6 to produce BC_2.
4. Similarly, a total of 120 BC_1 seeds from the cross of HA-R6/HA-DM1 were germinated. Seventy five seeds with suitable length of root tip were inoculated with DM race 734. Of them, 33 resistant plants were selected and backcrossed to the recurrent parent HA-R6 to produce BC_2.
5. A total of 222 BC_1 seeds from the cross of CONFSCLR5/RHA 464 were germinated. One hundred fifty seeds with suitable length of root tip were inoculated with DM race 734. Of them, 14 DM resistant plants were selected and inoculated with rust race 336. Five plants resistant to both downy mildew and rust were selected and backcrossed to the recurrent parent CONFSCLR5 to produce BC_2.

II. Saturation mapping of DM resistance gene in HA 458 with SNP markers

To identify SNP markers linked to *Pl_{17}* gene in HA 458, a total of 41 SNP markers, 16 from NSA SNPs and 25 from SFW SNPs, were selected from linkage group 4, which cover the *Pl_{17}* region. Out of the 41 selected SNPs, 15 show polymorphism between two parents, and subsequently were genotyped in the F_2 population. The twelve SNPs were placed to LG4 genetic map, and two SNP markers flanked *Pl_{17}* at a genetic distance of 2.1 and 1.7 cM, respectively. A paper titled '*Pl_{17}* is a novel gene independent of known downy mildew resistance genes in the cultivated sunflower (*Helianthus annuus* L.)' was published on the journal of Theoretical and Applied Genetics.

III. Begin the process of identifying molecular markers for the resistance gene derived from RHA 468

RHA 468 is a DM resistant male fertility restorer line. F_2 and F_3 populations were developed from the cross of HA-R8 and RHA 468. Downy mildew resistance phenotyping of the F_3 population together with the two parents was conducted. One hundred and ninety F_2-derived F_3 families (30 seedlings from each of F_3 family, total 5,700 seedlings) were inoculated with DM race 734 and recorded for performance. With data collected from 183 F_3 families, 53 were homozygous susceptible, 30 homozygous resistant, and 100 heterozygous resistant. The results indicated that the downy mildew resistance in RHA 468 is controlled by a single dominant gene. Bulked segregant analysis located the DM R-gene to linkage group 1 of the sunflower genome. Genomic DNA was isolated for 183 F_2 individuals and parents, and genotyping of F_2 population with polymorphic SSR and SNP markers is underway.

Additional work

Development of the mapping population

The new downy mildew (DM) resistance was transferred from wild *Helianthus argophyllus* accession PI 494578 into cultivated sunflower. The cross between HA 89 and PI 494578 was made in 2012. To molecularly map this new gene, a BC_1F_2 population were obtained in 2014. A total of 216 BC_1F_2 plants were grown in greenhouse this year and was advanced to BC_1F_3 generation. The BC_1F_3 seeds were harvested in June, 2015. Phenotyping of downy mildew resistance in this BC_1F_3 population will be used to determine inheritance of DM resistance derived from *H. argophyllus* PI 494578. Tissue samples of 216 BC_1F_2 plants were collected and freeze-dried for DNA isolation and genotyping.

Beneficiaries

The beneficiaries of this research are broad and varied. It is estimated that 825 farmers nationwide (half of whom are in ND) will benefit directly by this project. There are five confection sunflower hybrid seed companies producing confection hybrids that would utilize the DM resistant gene(s) placed in a confection germplasm background. All of them have ND research locations. There are nine major confection sunflower processing plants located in ND, TX, MN and KS. There are numerous local receiving stations where seed is gathered and stored. The seed is later delivered to one of the nine plants for final processing. In order to satisfy customer needs, these processors must start with a quality product that is of the proper color, size and test weight. These plants are complete with the latest equipment such as electric eye sorters to insure that poor quality seed will be eliminated. Some of these plants take the seed to a consumer ready packaging. That includes roasting, salting, adding a variety of spices and distributing the products directly to sales outlets. According to Agricultural Economics Report No. 327-S "Economic Contribution of the United States Sunflower Industry", the direct impact of the confection sunflower industry is $275.7 million annually. That study was based on economic surveys conducted in 1991-93. It is very safe to assume that the 2015 number would be considerably greater.

In the last several years confection inshell sunflower has become a nationally distributed product. It can be found in retail shops across the country. There are several national brands

including David & Sons and Frito Lay brands, plus numerous regional brands. These companies depend on a consistent supply of product. Inshell confection sunflower has become a substitute for chewing tobacco among professional baseball players. Today, inshell sunflower is a popular snack for young athletes emulating their professional heroes.

The 2015 NSA Research Forum was held on January 8 - 9, 2015 in Fargo, ND. The postdoctoral researcher, Dr. Guojia Ma, of this project described the significant progress that has been made in developing confection sunflower DM resistance. The lead researcher, Dr. Lili Qi, reported the molecular mapping of the DM resistance genes in sunflower and their impact on sunflower breeding programs. This meeting was attended by 150 individuals consisting of growers, industry and public researchers. It is these individuals who will take the project to the final step of incorporating the identified resistant genes into their elite germplasm and then cross into finished hybrids, which would be ultimately planted by farmers in field.

The Focus Group annual meeting was held on February 24, 2015 and the lead researcher, Dr. Lili Qi, provided an update on the results and progress of this research project. The Focus Group consists of 30-40 industry and grower leaders along with researchers who help formulate long range sunflower research strategy.

The Sunflower magazine, a publication owned by the National Sunflower Association, had an article summarizing this project in the March/April 2015 issue. This publication is mailed to all sunflower producers and reach approximately 25,500 growers, researchers and industry individuals. The article is of special interest to the estimated 825 confection sunflower growers and another 500 crop consultants, and is archived on the NSA website for future reference for growers, consultants and breeders.

*Crop consultants are a very important group to reach since they advise their farmer clients on all aspects of crop production from seed selection to harvesting.

Lessons Learned

In our original plan, molecular mapping of DM R-genes derived from *H. argrophyllus* and RHA 468 would be conducted in the 2014 and 2015, respectively. However, when testing the seed germination of F_2 families from the cross of HA 89/*H. argrophyllus* we found some germination problem related to seed dormancy which could be derived from wild species *H. argrophyllus.* Normally, it takes four to six months to break dormancy. Therefore, we decided to do mapping work on RHA 468 first.

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Additional Information Available

Publications

Qi LL, Long YM, Jan CC, Ma GJ, Gulya TJ (2015) *Pl_{17}* is a novel gene independent of known downy mildew resistance genes in the cultivated sunflower (*Helianthus annuus* L.). Theor Appl Genet 128:757–767

Qi LL, Ma GJ, Long YM, Hulke BS, Markell SG (2015) Relocation of a rust resistance gene *R_2* and its marker-assisted gene pyramiding in confection sunflower (*Helianthus annuus* L.). Theor Appl Genet 128:477–488

Qi LL, Long YM, Ma GJ, Markell SG 2015 Map saturation and SNP marker development for the rust resistance genes (*R_4*, *R_5*, *R_{13a}*, and *R_{13b}*) in sunflower (*Helianthus annuus* L.). Mol. Breed. (Accepted on 07/03/2015)

Ma GJ, Seiler GJ, Markell SG, Gulya TJ, Qi LL (2015) Registration of two double rust resistant germplasms, HA-R12 and HA-R13 for confection sunflower. Plant Regist. (Accepted on 06/19/2015)

Meeting reports

Ma GJ, Markell SG, Qi LL (2015) Development of super confection sunflower effectively resistant to downy mildew and rust. Presentation at the National Sunflower Association Research Forum, January 7-8, 2015, Fargo, ND. Available: http://www.sunflowernsa.com/uploads/resources/798/super.confection_ma_2015.pdf

Qi LL, Jan CC, Foley ME, Cai XW (2015) 2014 progress for molecular mapping of the downy mildew resistance genes in sunflower. Presentation at the National Sunflower Association Research Forum, January 7-8, 2015, Fargo, ND. Available: http://www.sunflowernsa.com/uploads/resources/797/molecular.mapping_qi_2015.pdf

Manuscript in preparation

Qi LL, Foley ME, Cai XW, Gulya TJ (2015) Introgression and genetic mapping of a novel downy mildew resistance gene, *Pl_{18}*, from wild *Helianthus argophyllus* into cultivated sunflower (*Helianthus annuus* L.)

Local Foods Initiative

Final Report

Partner Organization: North Dakota Department of Agriculture

Project Summary

Since 2008 the North Dakota Department of Agriculture (NDDA) has played an integral role in the promotion of specialty crops in North Dakota. Through the help of this specialty crop block grant the department was able to achieve many successes to help further the competiveness of specialty crops in ND. This project helped raise consumer awareness of the specialty crop industry in ND along, with continuing to provide marketing opportunities for our specialty crop producers in the state. This project is timely in that the buying local movement that continues to sweep the country has many consumers, restaurants and retailers looking for local sources of specialty crops such as fruits and vegetables. During this grant cycle meetings with specialty crop producers were held across the state to hear about their needs. A survey was sent out prior to the meeting to help form the meeting agenda. Through the efforts of this grant the NDDA was able to impact over 50 farmers markets and over 150 growers of fruits and vegetables in our state. Previously funded projects that this grant has built upon include: The Hunger Free North Dakota Garden Project recording produce donations for a 5th straight growing season that allowed us to reach a milestone of one million pounds of produce donated over the five year life of the program. Social media and blogging outreach, by expanding the blogging challenge based on feedback from bloggers from the previous year to reach a larger online audience. Finally, the NDFMGA & Local Foods Conference, used lessons learned and suggestions from previous years to create a better conference experience for those who attended by expanding the conference to a two day event from a one day event the previous year.

Project Approach

Hunger Free North Dakota Garden Project

> The awareness of the Hunger Garden Project continues to grow. Early in the spring of 2014 a letter from both the Agriculture Commissioner and the director of the Great Plains Food Bank was sent out to encourage organizations to participate in the program. A press conference to highlight the program was held in July at the Great Plains Food Bank in Fargo. In late fall, we reached out to participating organizations and recorded the total pounds of produce donations accepted during the growing season.

Social media and blogging outreach:

> Social media and blogging outreach: The purpose of this outreach was to tap into the talents of local bloggers to help promote specialty crop production in ND. We selected five bloggers from around the state and gave them a different blog challenge each month. Below were the challenge topics:

July 2014: Going to a farmers market, looking for that special item

August 2014: My favorite veggie dish

September 2014: Picking your own (U-Pick) fruit or vegetable experience

October 2014: Apples

November 2014: Going back to the grocery store

December 2014: Selecting a Christmas tree

Blogs are featured on the ND Local Foods Facebook page. We also created a logo that some of the bloggers are using to identify the blogs they write as part of our challenge. The logo also created an identity for the challenge.

We experienced commitment challenges from the bloggers during the last grant cycle. Based on feedback from the bloggers, we changed the challenges to allow more flexibility and we offered compensation for stories. The changes to the program didn't help participation and no grant dollars were expended for this project.

NDFMGA & Local Foods Conference

The North Dakota Farmers Market and Growers Association (NDFMGA) & Local Foods Conference has turned into an annual event. This year's conference, just like conferences in the past, was very focused on educating specialty crop producers to help them be more competitive in the marketplace. Presentations focused on production practices and marketing topics to help producers make more educated business decisions about their specialty crop business. The 2014 conference was held on February 14 & 15 in Minot. Due to lower than expected attendance in 2013, many changes were made based on comments and conversations. First, the conference was extended to a two day event. Many felt that the one day event was just too packed and more time was needed for networking. The second change was moving it to the month of February. Winter is a less busy time for producers. The third change was to select a location that would work with us on custom menu options. After the conference, we had many positive comments about the changes. Attendance was up from the previous year and everyone in attendance took a lot of useful information back to their specialty crop business. Through the use of time sheets the local foods marketing specialist was able to track separately the time he spent working on the specialty crop related functions of the conference.

Consensus Council Inc. Regional Food System Working Groups

This project started in June 2014 with a planning meeting with the Consensus Council. The budget and scope of work were discussed and a plan was formed to divide the project in two parts. The first part included an online survey to gauge the level of commitment from specialty crop producers and identify challenges and opportunities within the industry. The second step included regional meetings. The survey results would be used to help set up the agenda for the regional meeting. Since the survey was added and travel would be needed for the regional meetings, it was determined that two regional meetings will be held during this grant cycle. Meetings were scheduled in Dickinson and Minot in the fall. The survey was sent out the middle of August and producers were given three weeks to respond.

The survey questions included:

1. In what city and county do you reside?
2. How far from your home do you sell your products? Ranges were offered to choose from. 0-5 miles, 6-25 miles, 26-50 miles and over 51 miles.
3. What type of products do you grow and sell? The question offered a list of 20 popular specialty crops. Those surveyed could check all the specialty crops they grew and a line was provided for them to write in others.
4. What are the two biggest challenges to growing your specialty crop business? Open for written comments
5. What are two management and/or sales practices that have helped you most to succeed in your specialty crop business? Open for written comments
6. What can state agencies like the ND Department of Agriculture and/or the ND Department of Health do to be of assistance to you and your specialty crop business? Open for comments

- In September, we ran into an issue with the regional meetings. Based on state procurement guidelines the total dollar amount of the regional meetings required three bids. Three bids had been received but they were not in the time frame required by state guidelines. A decision had to be made to continue the meeting without the help of the Consensus Council or postpone them. As we reviewed the goals of the grant, a group like the Consensus Council was going to be used because "A professional third party mediator will eliminate any side being taken in discussion between specialty crop producers and health units and ensure that all voices are heard." For this reason the meetings were postponed. Since the surveys had already been sent out the Consensus council was paid for the survey work. In January 2015 bids were secured per state procumbent guidelines and a mediator was selected.
- Meeting were scheduled for the spring in Dickinson and Minot. Opened ended questions were asked that facilitated further discussion. Questions included, what have been some of the challenges of the past? What has worked to help you grow or market the products you grow? What can the NDDA do to help you as a producer? The Dickinson meeting had poor specialty crop producer attendance. We connected with a faculty member from Dickinson State College. He showed a strong interest in wanting to help specialty crop producers with challenges, but as shown by the attendance of the meeting either producers in that region are too few or they prefer to work independently. Specific topics at the Dickinson meeting included the inconsistency across the state of regulations for

specialty crop producers, standardizing language used when talking about regulations, and helping producers better understand how regulations vary depending on who they are selling to, example selling vegetables at a farmers market vs. to a restaurant. More exploratory work needs to be done in this region to identify specialty crop producers. It is too early to start a working group in that area. The meeting in Minot had six producers in attendance. There is a strong working group already established around the Minot Farmers Market. There is also a specialty crop producer who is developing a food hub and has started a grassroots effort with other producers. The efforts in this region are very promising for fruit and vegetable producers. Specific topics at the Minot meeting included: inconsistency across the state of regulations for specialty crop producers, how following different regulations takes more time and paperwork for a producer, producers plan two years in advance so regulations need to be consistent, and how can growers work with large grocery store chains to encourage them to buy more produce grown in North Dakota. The NDDA will monitor their progress and provide assistance as needed. In both meetings, regulations were talked about as being a barrier. Producers expressed their gratitude for the efforts the NDDA has made to help producers better understand their local regulations but the NDDA.

Goals and Outcomes Achieved

Hunger Free North Dakota Garden project

The overall goal of this project is multi-faceted. First, the project raises awareness that food helper organizations can accept fresh produce donations and get those donations into the hands of people that need them. Second, try to increase donations of fresh fruits and vegetables to organizations that provide food assistance. Thirdly, to raise awareness of the need for food assistance in ND.

At the end of the 2014 growing season the project reached a milestone by documenting over 1M lbs. of produce donations during the first five years of the program. Just over 125,000 lbs. of donations were collected during the 2014 growing season.

http://bismarcktribune.com/news/local/bismarck/farmers-produce-donations-top-m-lbs-to-feed-hungry/article_1ffc45f2-aa68-5571-a056-066d872cbb2f.html

The NDDA worked directly with 55 food pantries, and with our partnership with the Great Plains Food Bank we were able to connect and raise awareness of the program to over 200 organizations across the state. Our initial goal was to work with 85 organizations.

The NDDA developed a series of TV commercials as a tool to help raise awareness and increase donations. Those commercials were aired on stations across ND in both the spring and during harvest season in the fall.

Social Media and Blogging

The NDDA Facebook page has proven to be an effective way to reach our target audience and engage them in conversations about supporting the specialty crop industry. We currently have 1,258 fans, short of our goal of 1,500 when this project was written. Our twitter account has seen positive growth. Our goal was to increase followers to 125 and our current followers are at 507. Our efforts to reach out to bloggers have been mixed. Early in the project six bloggers were contacted and told of the new blogging topics. Unfortunately, none of the bloggers responded and participated. So to try to reach out a new group of bloggers the local foods marketing specialist became a member of a ND bloggers Facebook group. The marketing specialist did make contact with two bloggers through this page and they allowed the NDDA to share blog posts. However these bloggers were not interested in writing about pre-determined topics.

Consensus Council Inc.

In the end, this activity proved to be very beneficial to the growers in our state. The goals of the project were to look into regulations and the concept of local foods regional working groups to be a more effective way to work with and understand the needs of specialty crop growers. As the NDDA worked through this activity there were many lessons learned that will be covered in the section below. A survey was conducted to get a better understanding of the needs of specialty crop producers. Those survey results are below in the additional information section. At the meetings it was identified that the regulation issues are beyond the scope of what the grant or future grants could cover. The NDDA has always hypothesized that there were few growers in the western part of the state and these meeting confirmed this theory. Zero specialty crop producers attended the meeting in Dickinson. The meeting was attended by individuals that had an interest in helping producers but with no producers a regional working group is a long way from being formed in that area. The second meeting in Minot was attended by seven specialty crop growers and there is already a good working groups formed around the farmers markets. The farmers markets in that region could prove to be a good resource for the NDDA to work with on different issues. In the proposal for this grant suggested holding eight regional meetings. However, as the NDDA started to work through the logistics of holding the meetings with facilitators, it was determined that a survey and fewer meeting across the state would be just as effective and save travel and expenses. The NDDA also determined that to better complete the work a third phase with meetings in the eastern part of the state and a state wide stakeholder meeting would be future work.

Beneficiaries

Hunger Free North Dakota Garden Project

73,948 North Dakota residents.

Based off the Great Plains Food Banks estimates that in 2014 one in ten North Dakotans sought food assistance.

Groups that benefited from this project include the Great Plains Food Bank, FFA, 4-H and over 200 food pantries, soup kitchens, and other food assistance organizations across the state.

NDFMGA & Local Foods Conference

79 Specialty crop producers across in attendance representing over 20 statewide farmers markets. These producers benefited by attending presentations and breakouts sessions to learn how to better grow and market the specialty crops they raise.

Other groups that had representation included North Dakota State University(NDSU), NDFMGA Dakota College at Bottineau, USDA Rural Development, FFA, 4-H, local health units and the Minot Convention and Visitor Bureau.

Consensus Council/Regional Local Foods Working groups concept

These meeting were attended by a wide range of people. At the meeting in Dickinson, a professor from Dickinson State College was interested in starting classes for specialty crop producers and an NDSU extension agent was going to take the information to producers they work with. The Minot meeting was attended by market managers from two local markets. Also in attendance was a producer that is starting a food hub in the area. An NDSU Extension agent was in attendance that presented concerns she gathered from four specialty crop producers. Even though the actual number of attendees at the meetings may not seem high, there were a lot of influential people in attendance that will carry the information out to producers in the areas.

Lessons Learned

Blogging Challenge

The lesson learned is that bloggers write on their own timelines and about topics that interest them. The NDDA's attempts to have bloggers write about topics that we assign to them was not effective. Also, the first year we did this project we had greater success then the second. After visiting with some of the bloggers, they felt the newness wore off the second year. As one blogger told us to keep readers coming back to read my blog I have to always look for fresh content and writing about the same topic (specialty crops) over and over again gets old to readers. Other bloggers expressed concerns that because of the grant guidelines they felt too restrictive in what they could write. Since the NDDA does not have its own blog or bloggers on staff to control the message we will not be perusing this project in the future. .

Consensus Council/Regional Working Groups concept

The Consensus Council was utilized to gather an informal bid during the grant writing process; they did not win the procurement bid and we utilized a different company for this project. This caused discrepancies and confusion during the work. In the future, we learned to write grants around the goal and not include specific businesses in the projects. A positive lesson learned is that specialty crop producers appreciated the NDDA coming to their communities. These meeting helped strengthen relationships between specialty crop producers and the NDDA and also created allies for future projects. Thirdly, to run a quality meeting takes a lot of planning. Everyone is busy and if you are going to expect producers to come to a meeting you need to make it worthwhile for them. Quality over quantity is a key concept for future projects.

Contact

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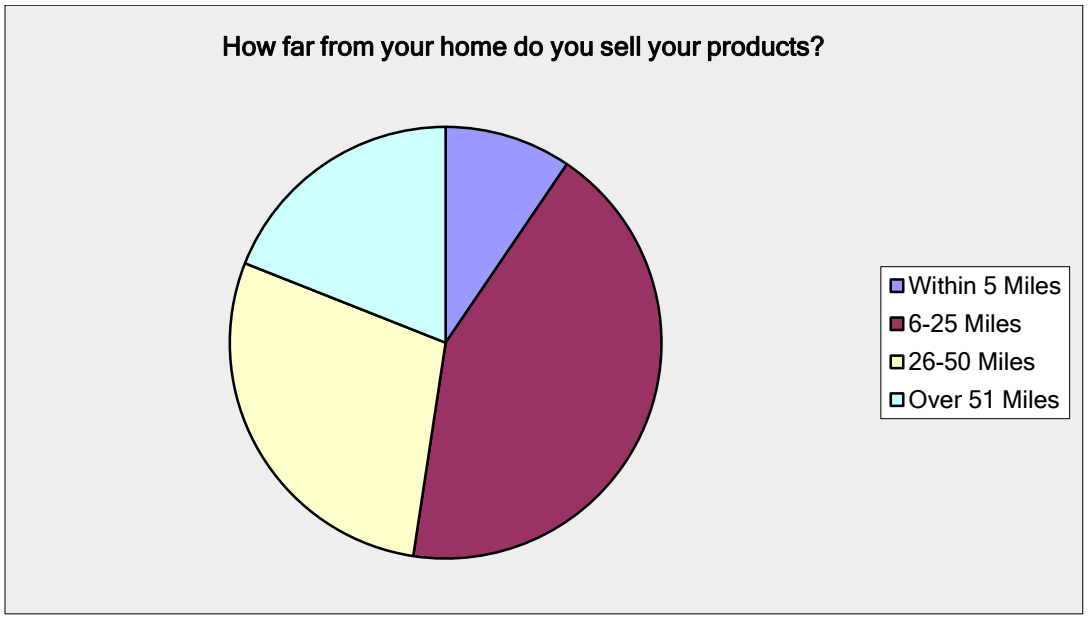
Additional information available

Consensus Council Survey Results

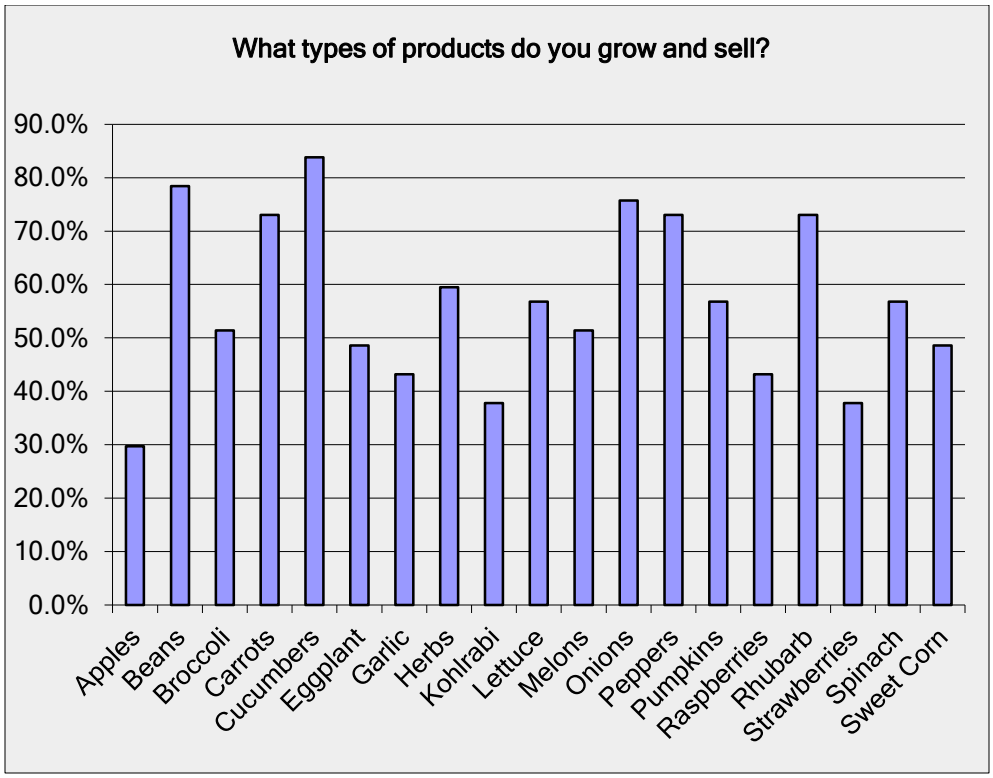
Question 1. In what City and County do you reside?

Survey results received from producers in 26 of the 53 counties across ND. Most of the producers from the eastern two thirds of the state.

Question 2:



Question 3:



Question 4: What are the 2 biggest challenges to growing your specialty crop business?

Top 5 answers grouped by category

1. Weather
2. Pest/Weed Control
3. Time management
4. Labor
5. Markets to sell & marketing product

Question 5: What are 2 management and/or sales practices that have helped you most to succeed in your specialty crop business?

Top 5 answers grouped by category

1. Professional Marketing
2. Direct consumer contact
3. Growing produce that is in demand
4. Quality of produce
5. Good Farming practices

Question 6: What can state agencies like the ND Department of Agriculture and/or the ND Department of Health do to be of assistance to you and your specialty crop business?

Top 4 answers grouped by category

1. Regulations
2. Marketing education
3. Grant opportunities
4. Pricing Assistance

2015 NDFMGA & Local Foods conference

Schedule of Events

Friday, February 14, 2014

11:00 - 11:30 AM – Registration
11:30 - 12:25 - Light Lunch Welcome and Introductions- Doug Goehring, North Dakota Agriculture Commissioner; Marvin Baker, President, ND Farmers Market & Growers Assoc.
12:30 – 1:45 - Bruce Smith, County Agent Dawson County, Montana
Break Out Sessions

	PRODUCTION	FINANCE
1:50 - 2:45	***Grafting*** *Matt Kleinhenz*, Extension Vegetable Specialist, The Ohio State University	***Business Development*** *Keith Knutson*, Dakota College at Bottineau
2:45 - 2:55	**Break**	
3:00 - 3:55	***Varieties That Do Well in High Tunnels*** - *Mark Boen*, Owner Bluebird Gardens	**Financing Options, Opportunities** *APUC-John Schneider, SARE-Karl Hoppe, Bill Hodous FARRMS-Sue Balcom, USDA Rural Development-Josh Kramer, ND Dept. of Tourism Dean Ihla*

4:00 – 5:00 - High Tunnel 201 – Mark Boen & Matt Kleinhenz
5:00 – 5:30 - Hotel Check in, prepare for evening activities
5:30 – "Loving Local" Banquet, NDFMGA Annual Meeting & Social to follow

Hotel Information
A block of rooms has been reserved for Friday, February 14, and Saturday, February 15, at the Grand Hotel, Minot. Ask for the "ND Farmers Market & Growers Association room block." Room rates expire January 31, 2014.
Phone: 701-852-3161
Address: 1505 North Broadway, Minot, ND 58702

Saturday, February 15, 2014

8:00 - 8:30 AM - Registration
8:30 – 9:45 – Brett Olson, Renewing the Countryside
9:45 – 10:30 – What is Kraft Brewing in North Dakota? Mike Frohlich, Laughing Sun Brewery, Bismarck
10:30 – 10:40 Break
Break Out Sessions

	PRODUCTION	MARKETING
10:45 - 11:45	**Improving Soil Health** *Theresa Podoll, Farmer, Jay Fuhrer*, NRCS District Conservationist	***Packaging and Labeling to Attract Customers*** *Holly Mawby*,owner Gardedweller Farms; *Annie Carlson*, owner Morning Joy Farms
11:50 - 12:55	**Lunch with Organizational Updates**	
1:00 - 1:55	**Specialty Crop Opportunities in the State** *Mike Frohlich; Greg Temple*, Maple River Winery; *Glenda Fauske, ND Forest Service*	**Food Hubs** *Bruce Smith*
2:00 - 2:45	**Ergonomics of Gardening** *Crystal Grenier*, Dakota College at Bottineau	**Marketing Through Social Media: "Telling your Story."** *Rachel Brazil, Writer*
2:45 - 2:55	**Break**	
3:00 - 3:55	**I Didn't Think I Could Grow That?** *Marvin Baker*	**Food Tours** *Brett Olson*

4:00 – 5:00 Climate: What to Expect... Weather! - Greg Gust

Agenda and speakers subject to change.

Name: _____

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Selection, Evaluation and Propagation of Ornamental Woody Plants for the Northern Great Plains

Final Report

Partner Organization: North Dakota State University

Project Summary

The Northern Great Plains is a diverse intercontinental environment with limited woody plant species that have been evaluated for use in USDA hardiness zones 3 – 4. Dr. Dale E. Herman developed the North Dakota State University Woody Plant Improvement Program in the 1970's. Over the years, this project has introduced 51 superior woody plants for production and sale with increased disease tolerance and winter hardiness for landscapes throughout the Northern Great Plains. This proposed project will be a continuation of the current program to evaluate potential woody plant species for use in landscape applications. Objectives of this project include: 1. Identifying sources of woody plant germplasm with potentially desirable traits; 2. Evaluate accessions of new or untested species to determine establishment, winter and drought hardiness, soil adaptation, pest susceptibility, aesthetic characteristics and survival; 3. Establish practical means of propagating selected woody plants utilizing shoot forcing to produce softwood shoots that can either be used as cutting or tissue culture propagules.

The impact of this project will enhance, diversify and increase the inventory of usable landscape plants for USDA hardiness zones 3 – 4. Currently, there is limited woody plant improvement research being conducted for USDA hardiness zones 3 – 4 with the NDSU program being a major research entity in the region. The current impact of the NDSU Woody Plant Improvement Program is with the 51 introductions being propagated for sale by commercial wholesale firms in three countries; Australia, Canada and the United States (14 states, including 35 nurseries). Increasing woody plant species for use in landscaping applications would have a significant impact on residents specifically in North Dakota and throughout the region. There would also be a positive financial impact to the nurseries growing woody plants in North Dakota by providing new plant materials that has been selected and evaluated for the Northern Great Plains to be produced for sale. Providing new information on propagation of selected species will have a significant impact on the nursery industry within the state and region. Research will assist in providing methods to reduce the need for grafting and potentially will increase woody plant survivability and longevity.

This project did not build on a previously funded project with the SCBGP or SCBGP-FB.

Project Approach

Project Activities

- Woody plant germplasm will be collected and purchased through seed companies to be evaluated for potential use in this climate range.
    - Germplasm seed lists have been generated targeted as potential new plants for the Northern Great Plains (Table 1.).
    - This activity was delayed with the notice of grant award in January 2014. Germplasm lists were generated with purchasing, and germination trials began in May – July 2014 which were proposed for Fall 2013.

- Germination trials were conducted and seedlings were grown out in the NDSU greenhouses. Germination data will be collected.
    - Germination trials were conducted throughout Fall and Winter 2014/2015. Many of the species required long stratification periods for germination. Germination trials produced numerous seedlings of each selection for trial.
- Seedlings will be planted at the NDSU Horticulture Research Farm located near Absaraka, ND in the seedling plots.
    - Seedlings were not planted in fall 2014 as planned at the NDSU Horticulture Research Farm but commenced in Spring 2015. This was a result of the general delay in funding dispersal.
- Data will be collected on establishment, winter and drought hardiness, soil adaptation, pest susceptibility, aesthetic characteristics and survival.
    - Winter survival data collection for 2016 is ongoing. Survival data is being compiled and will be utilized for future seedling planting decisions and recommendations.
- Seasonal shoot forcing research will be conducted with comparison of rooting softwood shoots directly in greenhouse with softwood shoots rooted in tissue culture.
    - Season Shoot Forcing experiments were conducted during this period. Shoot forcing experiments were initiated for *Betula tianshanica* TS 95115 (Tianshun Birch) and *Acer triflorum* Jack-O-Lantern' Orange Aglo™ Threeflowered maple.
    - Successful shoot forcing of *Acer triflorum* 'Jack-O-Lantern' Orange Aglo™ Threeflower maple was conducted. This is an introduction from the NDSU Woody Plant Improvement Program in 2011. Prior to this research grant, all propagation attempts were unsuccessful including grafting and cuttings as a result of mature tissue present. Shoot forcing allowed for the production of juvenile tissue and successful rooting of a recalcitrant species.
    - Softwood shoot produced via shoot forcing were screened for use in tissue culture including disinfestation protocols as well as production protocols.
    - Softwood shoots produced either by tissue culture or directly in greenhouse were compared for rooting capabilities including species such as: *Acer rubrum* (Red Maple), *Betula tianshanica* (Tianshun Birch), *Magnolia acuminata* hybrids (Magnolia), *Platanus occidentalis* (Sycamore).
    - Long-term woody plant evaluation will be ongoing and is essential for success of this project. Most of the NDSU selections have been evaluated for 20+ years prior to being released as a superior selection for ND. This ongoing long-term evaluation provides essential information based on environmental differences from year-to-year. All of the planted seedlings at the NDSU Dale E. Herman Research Arboretum survived the 2015-2016 winter as a result of a warmer, milder and shorter in duration winter than average. Each winter is uniquely different which supports the need for long-term evaluation prior to any recommendations being given on a specific selection other than potential usage based on limited winter survival data.
- Research overview update was given at the NDSU Horticulture Research Farm and Dale E. Herman Research Arboretum Field Day in Fall 2014 and 2015 with approximately 75 – 100 attendees each year.

- Presentations at North Dakota Nursery and Greenhouse Association (NDNGA) and ND Urban and Community Forestry Association annual meetings. Research overview update was given at the 2015 and 2016 NDNGA and NDUCFA combined annual meeting in January of each respective year with approximately 100 attendees each year. This update included propagation information and updates on survivability of potential new species for ND.
- Published articles in NDNGA and NDUCFA newsletter and website. Information gathered from this project has been provided for newsletter and website publication with subsequent long-term evaluation data being provided in the future.

Goals and Outcomes Achieved

Expected Measurable Outcomes:
Goal: 1. To increase the number of adapted, winter hardy, pest resistant woody plants for landscape uses in the Northern Great Plains produced by North Dakota commercial nurseries.
Goal 2. To provide information to the commercial growers on how to propagate these superior selections of woody plants.

Performance Measure: Number of North Dakota commercial nurseries that produces NDSU woody plant selections.

- Benchmark: Currently, only a portion of the North Dakota commercial nursery growers produce NDSU woody plant selections that are superior to other commercially available nursery stock.
- Target: To increase the number of North Dakota commercial nurseries that produces NDSU woody plant selections. To increase the number of NDSU woody plant selections with North Dakota nurseries already producing NDSU selections.
- Data Collection Plan: During the beginning of this project, North Dakota commercial nurseries will be contacted to determine the number of NDSU woody plant selections being produced. Propagation information will be transferred to the commercial growers including clonal material to increase availability of superior nursery stock available for North Dakota residents. If an increase in production of NDSU selections in not being done, changes to the program will be made to determine why and how to assist the commercial growers in increasing production and availability of NDSU selections.
- The limiting factor with commercial production in ND is the lack of propagation infrastructure. The required infrastructure for propagation is very specific and can be quite costly as a result of specific growth requirement and skilled labor. Propagation of clonal cultivars requires skill with grafting (highly skilled labor) and cutting propagation and both require specific production facilities that most growers do not currently possess.
- Propagation information was created for several of the NDSU releases and provided to commercial growers including information on grafting, cutting propagation and plant tissue culture.
- In 2013, a total of 12 NDSU selections were being produced (Table 2.). As of spring 2016, there are a total of 25 being produced for commercial sale with an increase of an additional 13 selections (Table 2.). This is a result of more nurseries having propagation materials made available for commercial nurseries.
- Dissemination activities included providing clonal propagation materials to commercial nurseries desiring to propagate NDSU selections and propagation information was

provided to commercial nurseries with respect to grafting, cutting propagation and tissue culture protocols as requested. Other dissemination activities included presenting evaluation and propagation information at the NDSU Horticulture Research Farm and Dale E. Herman Research Arboretum Field Day in Fall 2014 and 2015. Two research publications and two research abstracts were presented at national horticulture meetings.

Beneficiaries

This research project is important and timely because the importance of ornamental trees has increased in the state of North Dakota with the significant increase in population across the entire state. Commercial nurseries and landscapers are limited with the type of plants that can be grown and planted in this climate based on winter hardiness.

The specialty crop beneficiaries of this project are commercial nursery producers and retail garden centers across the state of North Dakota and professional landscape installation and management companies. Many of these beneficiaries are members of the North Dakota Nursery and Greenhouse Association (NDNGA). Both groups will benefit from this project by providing new superior ornamental woody plants to be utilized in landscapes. Residents of North Dakota will also benefit from this project with the availability of new superior ornamental woody plants to be enjoyed in their landscapes across the state.

- The expected number of specialty crop beneficiaries is 100. These 100 beneficiaries include both commercial and retails nurseries that will benefit from commercial sales of new woody plant materials that have been trialed here for winter survival.
- There will also be a positive financial impact to the nurseries growing woody plants in North Dakota by providing new plant materials that has been selected and evaluated for the Northern Great Plains to be produced for sale directly within North Dakota.

Lessons Learned

One key factor that was overlooked with this research proposal was the amount of refrigerated cooler space required for stratifying and overwintering young seedlings for evaluations. Seeds are collected, stratified and germinated in a single season. If future seedling evaluations are to occur at NDSU, refrigerated coolers would need to be purchased in order to conduct the research. Space at the NDSU Dale E. Herman Research Farm is limited as well and essential for long-term evaluation studies such as this.

Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.

Contact

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Additional information Available

Publications – Refereed Journal Articles

West T.P. and N.J. Jahnke. 2015. Micropropagation of 'Blue Moon' wisteria. Propagation of Ornamental Plants 15(1):28-33.

West, T.P., S.L. DeMarais and C.W. Lee. 2014. Germination of non-stratified Japanese tree lilac seeds as influenced by seed capsule maturity and moisture content. HortTechnology 24(2):177-180.

Publications – Abstracts

West T.P. and N.A. Maren. 2015. Utilizing anti-auxin to increase axillary shoot proliferation rate of Japanese elm. HortSci. 50(9):S166.

Jahnke, N. and T.P.West. 2014. Effects of Nutrient Salt Formulation and 6-Benzylaminopurine on Micropropagaiton of 'Blue Moon' Wisteria. HortSci. 49(9):S335.

Table 1. Germplasm Seed List Generated from 2013 – 2015 for Long-term Evaluation at NDS Dale E. Herman Research Arboretum.

TS Number	Scientific Name	Common Name	Type or Form	Source Material	Source Location	Contact Person	Comments
TS13002	Betula costata dwf	Dwarf korean birch	Dwarf birch	seed	Absaraka	GM	Seed from original dwf plant for comparison or rootstocks
TS13003	Cercidiphyllum japonicum	Katsura tree	Ornamental deciduous tree	seed	Carlton Plants, Or.	Mike Anderson	Propagate for trial, comparison, or rootstocks
TS13004	Pinus mugo uncinata	Upright mugo pine	Hardy evergreen small tree	seed	NDSU Langdon Station	GM	Propagate for trial, comparison
TS13005	Wisteria macrostachys	Blue Moon cultivar	Hardy flowering vine	284 seeds	NDSU campus	TW, GM	Propagate for progeny trial, seed treatments
TS13007	Wisteria frutescens var. macro.	F2-Betty Mathews	Hardy flowering vine	15 seeds	Mn.		Propagate for progeny trial, seed treatments
TS13008	Abies concolor 11619-1	Concolor or White Fir	evergreen tree	seed	Bowman Haley Dam	Vern Quam	Propagate for trial
TS13009	Abies concolor T2T1	Concolor or White Fir	evergreen tree	seed	Bowman Haley Dam	Vern Quam	Propagate for trial
TS13010	Abies concolor, unreadable	Concolor or White Fir	evergreen tree	seed	Bowman Haley Dam	Vern Quam	Propagate for trial
TS13011	Abies concolor, R2T2	Concolor or White Fir	evergreen tree	seed	Bowman Haley Dam	Vern Quam	Propagate for trial
TS13012	Abies concolor, R4T1	Concolor or White Fir	evergreen tree	seed	Bowman Haley Dam	Vern Quam	Propagate for trial
TS13059	Castanea dentata	American chestnut	large deciduous tree	seed			
TS13060	Castanea dentata	American chestnut	large deciduous tree	seed			
TS13061	Cornus kousa	Kousa Dogwood	medium deciduous tree	seed			
TS13062	Fagus sylvatica 'Asplenifolia'	Earopean beech, cut le	large deciduous tree	seed			
TS13063	Ulmus parvifolia 'Halleluha'	Lacebark elm	medium deciduous tree	seed			
TS13064	Pseudotsuga menziesii	Douglas fir	Hardy evergreen tree form	seed			
TS13065	Aesculus hippocastanum	European horse chest	large deciduous tree	seed			
TS13066	Aesculus hippocastanum	European horse chest	large deciduous tree	seed			
TS13067	Aesculus glabra	Ohio Buckeye	compact, upright tree	seed			seed from TS13006, Lavaburst Buckeye
TS13068	Aesculus glabra hybrids	Buckeye	medium deciduous tree	seed			seed from Prairie Torch
TS13069	Aesculus glabra arguta	Texas buckeye	small deciduous tree	seed			seed from Carrington tree
TS13072	Magnolia acuminata	Cucumber tree	large deciduous tree	seed	UW Arboretum		
TS13073	Pinus bungeana	Lacebark pine	medium evergreen tree	seed	Green Bay Botanic Gardens		
TS13076	Magnolia acuminata 'Yellow Fever'	Yellow Fever Magnolia	large deciduous tree	seed	Morton Arboretum		open pollinated seed
TS13077	Magnolia kobus - Pink	Pink Kobus magnolia	large deciduous tree	seed	Green Bay, Wi.	Dennis Ledvina	
TS13082	Stewartia hybrid	Hybrid Stewartia	large deciduous tree	seed	University of Maine		suspected hybrid between S. pseudocamellia and S. koreana
TS13175	Carya ovata	Shagbark Hickory	large deciduous tree	seed	Johnson Nursery, WI		2 seeds
TS14013	Tilia americana	American linden	large deciduous tree	seed	NDSU Absaraka		Dakota American Linden
TS14021	Hemiptelea davidii		large deciduous tree	seed	UW Arboretum		
TS14041	Nyssa sylvatica	Black Tupelo	large deciduous tree	seed	UW Arboretum		tree near visitor's center
TS14042	Pterocarya spp.	wingnut	large deciduous tree	seed	Blanchardville, WI	Larry Cadman	
TS14073	Abies squamata	Paperbark Fir	large deciduous tree	seed	FW Schumacher		
TS14074	Pseudotsuga menziesii	Douglas fir	large deciduous tree	seed	Wheatland Cemetary		upper canopy
TS14075	Pseudotsuga menziesii	Douglas fir	large deciduous tree	seed	Wheatland Cemetary		lower canopy
TS14076	Ulmus gaussonii	Hariy elm	large deciduous tree	seed	Sunshine Nursery		
TS14078	Ulmus lamellosa	Hebei Elm	large deciduous tree	seed	Sunshine Nursery		
TS15029	Cornus mas	Cornellian Cherry	multi-stem shrub	seed	UW Arboretum		open pollinated seed from 'Spring Glow'
TS15030	Cornus mas	Cornellian Cherry	multi-stem shrub	seed	Allen Centennial Garden, UW Madison C		open pollinated seed from unnamed cultivar
TS15032	Cornus mas	Cornellian Cherry	multi-stem shrub	seed	UW Arboretum		open pollinated seed from 'Pyramidalis'
TS15033	Ulmus parvifolia var. coreana	Korean Elm	large deciduous tree	seed	UW Arboretum		
TS15034	Ulmus parvifolia 'Halleluha'	Lacebark Elm	large deciduous tree	seed	UW Arboretum		
TS15035	Hemiptelea davidii		large deciduous tree	seed	Haverford College Arboretum, PA		
TS15088	Viburnum opulus	European cranberry bu	multi-stem shrub	seed	NDSU Absaraka		Seed from early fall color selection

Table 2. NDSU Woody Plant Selections Produced by Commercial Nursery Growers

NDSU Selections Produced – 2013	
1. Meadowlark Forsythia	*Forsythia* x 'Meadowlark'
2. Blueberry Delight® Juniper	*Juniperus communis* var. *depressa* 'AmiDak'
3. Dakota Goldcharm® Spirea	*Spiraea japonica* 'Mertyann'
4. Dakota Sunspot® Potentilla	*Potentilla fruticosa* 'Fargo'
5. Copper Delight™ Juniper	*Juniperus communis* var. *depressa* 'ReeDak'
6. Dakota Pinnacle® Birch	*Betula platyphylla* 'Fargo'
7. Prairie Radiance® Euonymus	*Euonymus bungeanus* 'Verona'
8. Prairie Statesman® Swiss Stone Pine	*Pinus cembra* 'Herman'
9. Prairie Torch® Hybrid Buckeye	*Aesculus* x 'Bergeson'
10. Prairie Dream® Paper Birch	*Betula papyrifera* 'Varen'
11. Prairie Horizon® Manchurian Alder	*Alnus hirsuta* 'Harbin'
12. Prairie Reflection® Laurel Willow	*Salix pentandra* 'Silver Lake'

NDSU Selections Produced – 2016 (additional to 11 produced in 2013)	
13. Copper Curls® Pekin Lilac	*Syringa reticulata ssp. pekinensis* 'SunDak'
14. Northern Acclaim® Thornless Honeylocust	*Gleditsia triacanthos* var. *inermis* 'Harve'
15. Prairie Expedition® American Elm	*Ulmus americana* 'Lewis & Clark'
16. Prairie Stature® Hybrid Oak	*Quercus* x *bimundorum* 'Midwest'
17. Spring Welcome® Magnolia	*Magnolia* x *loebneri* 'Ruth'
18. Northern Tribute® River Birch	*Betula nigra* 'Dickinson'
19. Royal Splendor® Norway Spruce	*Picea abies* 'Noel'
20. Northern Flare® Sugar Maple	*Acer saccharum* 'Sisseton'
21. Prairie Pioneer® Dwarf Chinkapin Oak	*Quercus prinoides* 'Fort Lincoln'
22. Sea Foam™ Savin Juniper	*Juniperus sabina* 'Greenscape'
23. Northern Herald® Eastern Redbud	*Cercis canadensis* 'Pink Trim'
24. Northern Spotlight™ Korean Maple	*Acer pseudosieboldianum* 'KorDak'
25. Northern Empress® Japanese Elm	*Ulmus davidiana var. japonica 'Burgundy Glow'*

Developing Pinto Bean Breeding Lines with Multiple Resistance to Diseases of Importance in North Dakota

Final Report

Partner Organization: North Dakota State University

Project Summary

North Dakota is the largest producer of dry beans (*Phaseolus vulgaris* L.) in the U.S., accounting for almost 40% of the total, representing a production value of $420 million in 2012. Among all dry bean market classes, pinto bean is the most predominant in the country as well as in the state. However, several fungal and bacterial diseases limit seed yield and reduce quality every year. Effective resistance genes for bean anthracnose, common bacterial blight, and bean rust are available; however it is challenging to introduce them into lines with good agronomic performance. The objective of this project is to generate advanced pinto bean breeding lines with resistance against emergent races/strains of the pathogens in ND/MN causing anthracnose, common bacterial blight, and bean rust diseases, in combination with good agronomic performance specifically targeted for the ND/MN growing conditions. Toward this effort, early generation pinto lines have been generated by USDA-ARS that contain combinations of resistance genes effective against these diseases, but additional pathogen testing and field selections are needed to develop superior lines adapted to the ND/MN region. A final outcome of this project is the identification of superior pinto breeding lines that combine multiple disease resistance and competitive agronomic performance in ND/MN. Promising lines which meet necessary requirements would be released as commercial cultivars in the near future. The genetic material developed in this project is completely new and therefore, it is not directly related to previously funded SCBGP projects from this group. Nonetheless, the experience and lessons gained by this group from the other projects have been successfully applied to this one.

Project Approach

- Preliminary selections were made at USDA-ARS Prosser (Dr. P. Miklas) to select the pinto breeding lines to be sent for seed increase and generation advancement in the winter nurseries. Selection criteria included disease reaction in the greenhouse to common bacterial blight and white mold, as well as overall agronomic appearance.

- A total 125 $F_{3:4}$ pinto breeding lines with Multiple Disease Resistance (MDR) were grown in New Zealand in November 2014 and 109 lines were selected based on disease symptoms, plant architecture, and overall agronomic potential.

- A total of 96 $F_{3:5}$ pinto breeding lines were obtained in May from the winter nursery grown in New Zealand after selection was made based on disease symptoms, plant architecture, and overall agronomic potential.

- An additional group of 17 MDR breeding lines were obtained from Dr. Phil Miklas (USDA-ARS) in April 2014 for spring planting.

- A total of 113 MDR breeding lines plus 7 checks were planted at 2 locations in North Dakota (Hatton and Johnstown) in early-June 2014. Because of low seed availability in most lines, 2-row plots with 1 replication were planted at each location using an alpha design of 6 incomplete blocks with 20 genotypes each (120 total genotypes). Natural disease pressure was very high at Johnstown, which allowed the evaluation of the lines for three diseases simultaneously: common bacterial blight (CBB), white mold (WM), and halo blight (HB). No natural pressure of anthracnose was observed since this disease is only present in some fields in central ND. In addition to agronomic parameters (seed yield, seed size, days to maturity, plant height), a standard disease scale of 1 to 9 was used for all diseases, where 1-3 is resistant, 4-6 is intermediate, and 7-9 is susceptible.

- The same set of lines was planted at Othello-WA during the 2014 growing season for additional evaluation and production of disease-free seed. The field trial was planted in an alpha design of 6 blocks with 20 entries each with 2 reps (120 total genotypes). The lines were mostly evaluated for desirability (agronomic appearance) using the same 1 to 9 scale (1-3 undesirable, 4-6 acceptable, and 7-9 excellent), and all the agronomic traits mentioned above.

- Field trials were evaluated in July, August, and September of 2014 for the following traits:
    - Osorno and Pasche in ND: CBB, WM, HB.
    - Osorno and Miklas in WA: Agronomic appearance.
    - Osorno and Miklas in ND: WM, CBB, and desirability.
    - Osorno in ND: Desirability and maturity.

- After statistical analyses, a total of 64 MDR lines (56% of the total) were selected and harvested based on the disease resistance, agronomic performance, and desirability evaluations.

- As described in the project plan, greenhouse evaluation of the 64 field-selected MDR lines was made for their reaction to the following diseases:

- **Common Bacterial Blight (CBB):**
    - Inoculum = 1 X 10^7 Xcp/ml sterile distilled water
    - Strain: *Xap* f91-5
    - First trifoliate inoculated 21 days after planting with air brush
    - Plants put in humidity chamber for 24 hrs
    - Plants rated 21 days after inoculation
    - Scale = 1-9

- **Rust:**
    - Inoculum = 4mg rust/ 20 ml 0.01% Tween 20 in sterile distilled water
    - Race = 20-3
    - Primary leaves inoculated 10 days after planting
    - Plants put in humidity chamber for 24 hrs
    - Plants rated 14 days after inoculation
    - Scale = 1-9

- **Anthracnose:**
  - Inoculum = 1.2 R73/ml 0.01% Tween 80 in sterile distilled water
  - Race = 73
  - Primary leaves inoculated 10 days after planting
  - Plants put in misting chamber for 5 days
  - Plants rated 10 days after inoculation
  - Scale = 0-9

- Among these 64 MDR breeding lines, a total of 4 lines were rated highly resistant (disease severity score 0-3) and 11 more had high to moderate resistance (disease severity score 1-6) to all three diseases tested. In addition, 19 lines showed high levels of resistance to both anthracnose and rust, 9 lines to both rust and CBB, and 4 lines showed simultaneous resistance to both anthracnose and CBB (Table 1). However, given the contrasting results for the reaction of some breeding lines to CBB among the three replications of the experiment, a fourth replication was performed to confirm some results. Some of these results have been confirmed by evaluations made by other colleagues not directly involved in this project. These lines have also shown good agronomic characteristics based on the preliminary field evaluations during the 2014 growing season

- During the 2015 growing season, field trials of these 64 MDR lines plus 8 checks (72 genotypes total) were planted in late May at two locations in North Dakota (Johnstown and Hatton), and one location at Washington (Othello). A randomized complete block design with 2 reps was used at each location given the small amounts of seed available for some entries. Unfortunately, the field trial at Johnstown was lost due to flooding (excessive rainfall during June and July). Still, the remaining trials allowed us to have more accurate estimates for the agronomic performance (seed yield and size, plant height/architecture, earliness, etc.) of these lines by having data across 2 years (Table 2). Results from the field trials at Othello-WA are not included in this report (but are available under request), since we were mostly interested in local adaptation in the target region in North Dakota. Nonetheless, the trials at Othello-WA allowed us to identify the breeding lines with the highest yield potential under almost optimal conditions (no diseases, irrigation, etc.).

- In order to confirm the presence of some molecular markers previously used by P. Miklas for selection within these lines, DNA was obtained from one or two plants for each of the lines and controls. DNA was extracted used our modified CTAB protocol. Primers were obtained from Life Technologies for SBB14 and SAS13 for Anthracnose (*Co-4*^{2}), SI19, BARCPVSSR04582, BARCPVSSR04600 for rust (*Ur-5*), and CBB markers (SAP6, SU91, and BC420). Each of the primer sets were tested using published protocols (http://bic.css.msu.edu/_pdf/SCAR_Markers_2010.pdf), and modified as necessary to optimize conditions. Optimization was limited to a ten degree gradient as well as testing two different polymerases on the varietal controls. Primer sequences, final amplification profiles, and results are available under request.

- SAS13 amplified same size amplicon in all samples and therefore, it cannot be used a selection criteria in this set of lines. SBB14 amplified from most samples (94%) with the published sizes of ~1150 and ~1050 bp.

- SI19 and BARCPVSSR04582 (2901) amplified several very closely sized amplicons and was difficult to differentiate on agarose. BARCPVSSR04600 (2903) amplified a product for most samples and produced primarily two different amplicon sizes of ~280 and ~310. Confirmation of this marker is currently underway. SAP6 and SU91 amplified in a dominant fashion as expected. BC420 was not successfully amplified.

- In general, both rust and anthracnose markers were detected in most of the 64 selected breeding lines. This is expected since both of these markers were initially used as selection criteria for these lines during early generations. Contrastingly, CBB SCAR markers were detected only in ~80% of the lines. Both greenhouse and field evaluation allowed to identify several false positives (lines with reported marker but susceptible to the disease), and only lines with true resistance have been selected. The lack of accuracy of these markers, especially across different genetic background and market classes, has been reported previously.

- Statistical analyses of all the data from field, lab, and greenhouse showed that the lines with the highest levels of resistance to all 3 diseases were not necessarily the lines with the highest seed yield across the 2014 and 2015 growing seasons (Tables 1 and 2). This is not surprising since it has been reported that in some cases, cultivars with disease resistance can have a seed yield reduction in the absence of disease pressure. This is known is some cases as the "yield penalty". It is important to note that under field conditions, there was no presence of anthracnose, which is the most severe disease of the three evaluated under favorable conditions. CBB pressure was high while rust pressure was mild and only showing symptoms at the end of the cycle when the lines were already close to physiological maturity. White mold pressure was high, and even though this disease was not part of the breeding targets, we were able to eliminate several breeding lines with high susceptibility to white mold, suggesting that the remaining lines may have some levels of tolerance and/or avoidance to this disease.

Goals and Outcomes Achieved

- Visual (phenotypic selection) in the field of an initial set of 125 pinto breeding lines with multiple disease resistance allowed narrowing down this group to 64 lines that offered acceptable agronomic performance during the 2014 growing season. The same group of lines was tested during the 2015 growing season in order to have additional data to make selection decisions.

- Disease reaction for this set of lines was evaluated again in the greenhouse using the local races of the pathogen. Among these 64 MDR breeding lines, a total of 4 lines were rated highly resistant (disease severity score 1-3) and 11 more had high to moderate resistance (disease severity score 1-6) to all three diseases tested. In addition, 19 lines showed high levels of resistance to both anthracnose and rust, 9 lines to both rust and CBB, and 4 lines showed simultaneous resistance to both anthracnose and CBB (Table 1). It is very

important to note that all these lines already offer high levels of resistance while maintaining good seed characteristics typical of a pinto bean (shape, size, color, etc). This is in many cases a challenging task when improving for specific traits while maintaining the market class specific traits as uniform as possible.

- All these results combined allowed the identification of 6 breeding lines that may offer the best combination of multiple disease resistance and agronomic performance either similar or superior to the commercial checks (selected lines are highlighted in tables 1 and 2). This is far better than out initial target of identifying one breeding line:

    - NDZ14012
    - NDZ14043
    - NDZ14056
    - NDZ14088
    - NDZ14110
    - NDZ14120

- These breeding lines will be available for crosses and additional research to both public and private breeding programs. Additional yield testing is needed during the 2016 and 2017 growing seasons before making final decisions. If this multi-location yield testing shows that at least one of these lines is competitive or superior to commercial checks, it could be released as a new cultivar in the near future.

- The main goal of the project was to identify lines with multiple disease resistance to three very different diseases (two fungal, 1 bacterial). However, we were also able to identify additional lines with a combination of 2 out of the 3 diseases and some cases, very high levels of resistance to a specific disease. These lines are also of interest, especially for regions/areas where the major biotic factor is 1 or 2 of these pathogens.

- Results of this research have been shared with bean growers and industry at the Annual Bean Day held in Fargo-ND in January 2015 and 2016, where approximately 500 growers attend. In addition, a poster was presented at Plant and Animal Genome Conference (PAG) in San Diego-CA in January 2015, where ~4000 scientists attend. One poster and one oral presentation were given at the Biennial meetings of the Bean Improvement Cooperative (BIC) meeting held at Niagara Falls, Canada in November 2015. This is the most important meeting for bean scientists, with ~200 bean scientists from all the world attending. Results were also presented to the W-3150 multi-state group, which gathers most bean breeders and pathologists from US public institutions. Representatives from the private industry were also present at the meeting held right after the BIC. All presented material is available under request.

Beneficiaries

- The first short-term beneficiaries are other public and private bean breeding programs that could use these lines for crosses and additional testing and research. There are at least 7 public breeding programs in the U.S. with access to these lines. In the same way, there are at least 4 private companies who can also request the genetic material if interested.

- Medium and long-term beneficiaries are the bean growers in the region once the best breeding line is identified and released as a cultivar for commercial production in the region. Being North Dakota the largest producer of dry beans in the country, the economic impact will be significant by reducing the disease pressure (which is translated into higher productivity), and reducing and/or eliminating the need to apply fungicides. Therefore, the impact is not only economic but also environmental.

- North Dakota is the largest producer of dry beans in the U.S., accounting for almost 40% of the total, representing a production value of $480 million every year during the last 4 years. Among all dry bean market classes grown in the U.S., pinto bean is the most predominant both in the country and state, with approximately 40 and 60% of the total production, respectively. Therefore, if any of these breeding lines becomes a new variety, there is potential to partially contribute to the $480 million mentioned above. In addition, value of production could be increased by obtaining higher seed yields per acre with these new multiple disease resistance varieties.

Lessons Learned

- This project allowed the identification of several pinto breeding lines with multiple disease resistance. However, the challenge persists when the lines with the highest levels of resistance aren't necessarily the ones with the highest seed yield. Future research needs to focus on the negative correlations between disease resistance genes and agronomic performance. This is known in breeding/genetics as "linkage drag".

- Even though it well known that the molecular markers aren't perfect, they aid in reducing the population sizes under selection. However, the ultimate test is always to evaluate the genetic material with the respective disease in order to ensure the presence of the genes of interest.

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Additional Information

- Table 1. Disease reaction scores of 64 pinto breeding lines plus checks to anthracnose (0 to 9), rust (1 to 9), and CBB (1 to 9) (trifoliate and unifoliate) in the greenhouse.

- Table 2. Agronomic performance of 64 pinto breeding lines in North Dakota across 2 years (2014 and 2015).

Table 1. Disease reaction scores of 64 pinto breeding lines plus checks to anthracnose (0 to 9), rust (1 to 9), and CBB (1 to 9) (trifoliate) in the greenhouse. Lines with multiple disease resistance to 3 diseases are highlighted in yellow.

	Anthracnose		**Rust**		**CBB-Trifoliate**
Line	Mean Score*	Line	Mean Score*	Line	Mean Score*
NDZ14022	0	NDZ14008	1	NDZ14049	3
NDZ14026	0	NDZ14040	1	NDZ14094	4
NDZ14043	0	NDZ14041	1	NDZ14083	4
NDZ14045	0	NDZ14042	1	NDZ14013	4
NDZ14048	0	NDZ14052	1	NDZ14014	4
NDZ14056	0	NDZ14053	1	NDZ14066	4
NDZ14067	0	NDZ14054	1	NDZ14064	4
NDZ14069	0	NDZ14064	1	NDZ14043	4
NDZ14085	0	NDZ14066	1	NDZ14001	4
NDZ14086	0	NDZ14073	1	NDZ14054	4
NDZ14094	0	NDZ14082	1	NDZ14120	4
NDZ14099	0	NDZ14083	1	NDZ14069	4
NDZ14107	0	NDZ14110	1	NDZ14077	4
NDZ14110	0	NDZ14119	1	NDZ14006	4
NDZ14119	0	NDZ14120	1	NDZ14119	4
NDZ14073	0	NDZ14006	1	NDZ14015	4
NDZ14083	0	NDZ14028	1	NDZ14056	5
NDZ14097	0	NDZ14030	1	NDZ14012	5
NDZ14035	1	NDZ14048	1	NDZ14089	5
NDZ14120	1	NDZ14056	1	NDZ14051	5
NDZ14012	1	NDZ14077	1	NDZ14073	5
PT13-21	2	NDZ14005	1	NDZ14101	5
NDZ14125	2	NDZ14035	1	NDZ14040	5
NDZ14088	3	NDZ14045	1	NDZ14078	5
NDZ14102	3	NDZ14012	1	NDZ14110	5
NDZ14006	3	NDZ14069	1	PT12-4	5
NDZ14005	3	NDZ14125	1	NDZ14053	5
NDZ14078	3	NDZ14085	1	NDZ14067	5
NDZ14101	3	NDZ14097	2	NDZ14045	5
NDZ14008	3	NDZ14118	2	NDZ14107	5
PT13-14	4	PT13-21	2	NDZ14042	5
PT12-4	5	NDZ14067	2	PT13-17	5
NDZ14118	5	NDZ14086	2	NDZ14008	5
PT12-12	6	NDZ14101	2	NDZ14041	5

NDZ14014	7	NDZ14043	2	NDZ14088	5
NDZ14037	7	NDZ14099	3	NDZ14052	5
NDZ14001	8	NDZ14022	3	PT12-31	5
PT12-31	8	PT12-31	3	PT13-16	5
PT13-17	8	PT13-12	4	NDZ14037	5
NDZ14042	8	NDZ14102	5	PT13-15	6
NDZ14089	8	NDZ14037	5	PT12-12	6
NDZ14013	8	NDZ14094	5	NDZ14030	6
NDZ14049	8	NDZ14049	5	NDZ14022	6
NDZ14082	8	NDZ14088	6	NDZ14085	6
NDZ14077	8	NDZ14089	6	NDZ14099	6
NDZ14084	9	NDZ14107	6	NDZ14102	6
PT13-13	9	NDZ14078	6	PT13-21	6
NDZ14002	9	NDZ14051	6	NDZ14125	6
NDZ14066	9	PT13-14	6	NDZ14082	6
NDZ14015	9	PT13-22	7	PT13-22	6
NDZ14051	9	NDZ14014	7	NDZ14005	6
NDZ14054	9	NDZ14002	7	NDZ14084	6
PT13-16	9	NDZ14084	7	NDZ14048	7
NDZ14028	9	PT12-4	7	NDZ14086	7
NDZ14030	9	NDZ14001	7	PT13-12	7
NDZ14040	9	PT13-15	7	PT13-14	7
NDZ14041	9	PT13-13	7	NDZ14028	7
NDZ14052	9	NDZ14026	7	NDZ14097	7
NDZ14053	9	PT12-12	8	PT13-13	7
NDZ14064	9	NDZ14015	8	NDZ14118	7
PT13-12	9	NDZ14013	8	NDZ14026	7
PT13-15	9	PT13-16	8	NDZ14002	7
PT13-22	9	PT13-17	9	NDZ14035	8
ABCP-8	9	ABCP-8	1	ABCP-8	5
Buster	5	Buster	7	Buster	NT
Longs Peak	8	Longs Peak	3	Longs Peak	NT
Montrose	8	Montrose	1	Montrose	7
Othello	9	Othello	8	Othello	8
USPTCBB1	NT**	USPTCBB1	NT	USPTCBB1	4
USPTCBB5	NT	USPTCBB5	NT	USPTCBB5	4
VAX 3	NT	VAX 3	NT	VAX 3	3
Stampede	7	Stampede	2	Stampede	NT
USPT-ANT-1	1	USPT-ANT-1	NT	USPT-ANT-1	NT

*. Mean score (standard score from CIAT:: 1-3 Resistant, 3-6 Intermediate, 7-9 Susceptible.
**. NT: Not tested.

Table 2. Agronomic performance (sorted by seed yield), of 64 pinto breeding lines in North Dakota across 2 years (2014 and 2015). Lines with multiple disease resistance to 3 diseases are highlighted in yellow.

Line	Plant Height	Seed Yield	100-Seed Weight
	cm	lb/acre	g
NDZ14037	55	2725	32.0
NDZ14088	47	2640	30.9
NDZ14101	50	2570	29.1
NDZ14118	53	2570	29.8
PT13-12	58	2560	37.0
PT12-12	54	2540	33.0
PT13-16	54	2540	36.2
NDZ14014	51	2525	34.7
PT13-13	61	2525	35.3
NDZ14035	53	2495	31.8
NDZ14086	50	2490	35.9
USPT-ANT-1	56	2475	36.4
NDZ14110	49	2430	27.9
NDZ14085	53	2415	35.2
PT13-22	50	2405	41.3
NDZ14049	52	2405	39.9
PT13-14	59	2390	31.9
NDZ14013	52	2380	33.8
NDZ14048	56	2365	33.6
NDZ14102	52	2350	31.3
NDZ14043	48	2330	33.7
NDZ14012	54	2270	29.9
NDZ14097	56	2270	35.7
NDZ14045	46	2260	36.5
NDZ14008	55	2240	31.1
NDZ14064	50	2225	29.8
NDZ14026	51	2220	33.2
NDZ14041	48	2210	28.1
NDZ14005	46	2205	29.3
NDZ14030	54	2205	30.2
Windbreaker	45	2185	37.7
NDZ14099	50	2175	33.5
NDZ14077	47	2165	30.7
NDZ14073	46	2155	35.1
NDZ14051	53	2150	35.9

PT13-21	**54**	**2145**	**35.6**
PT13-17	**52**	**2140**	**34.1**
NDZ14089	**51**	**2135**	**30.2**
NDZ14067	**48**	**2130**	**31.7**
LaPaz	**52**	**2125**	**36.3**
NDZ14022	**48**	**2120**	**30.4**
ABCP-8	**42**	**2120**	**30.1**
Lariat	**54**	**2105**	**38.7**
NDZ14040	**52**	**2095**	**30.4**
NDZ14125	**53**	**2070**	**30.4**
NDZ14078	**50**	**2060**	**29.5**
NDZ14042	**50**	**2040**	**29.5**
Stampede	**55**	**2025**	**38.2**
NDZ14056	**56**	**2015**	**32.1**
NDZ14084	**49**	**1995**	**30.4**
NDZ14120	**49**	**1990**	**29.0**
NDZ14002	**48**	**1980**	**36.6**
NDZ14028	**51**	**1980**	**28.0**
NDZ14066	**50**	**1970**	**30.4**
PT13-15	**54**	**1955**	**35.4**
NDZ14082	**51**	**1950**	**29.6**
NDZ14006	**46**	**1925**	**29.7**
PT9-18	**45**	**1910**	**31.4**
NDZ14094	**42**	**1860**	**35.0**
NDZ14054	**41**	**1855**	**31.1**
NDZ14107	**43**	**1850**	**32.8**
NDZ14052	**49**	**1830**	**29.3**
NDZ14001	**42**	**1815**	**32.6**
NDZ14069	**47**	**1770**	**30.5**
NDZ14015	**41**	**1760**	**35.0**
USPT-CBB-5	**39**	**1745**	**33.9**
NDZ14119	**43**	**1720**	**33.7**
NDZ14083	**43**	**1720**	**32.7**
NDZ14053	**43**	**1670**	**29.9**
PT12-31	**44**	**1655**	**33.4**
PT12-4	**40**	**1285**	**29.3**
HIGH MEAN	**63.5**	**2870**	**41.3**
LOW MEAN	**38**	**1285**	**26.65**
EXP MEAN	**49**	**2150**	**32.8**
C.V. %	**12.5**	**20.1**	**7.65**
LSD 5%	**12**	**770**	**5.15**
LSD 1%	**17**	**1030**	**6.8**
# OF REPS	**2**	**2**	**2**
F-TRT	**2**	**1.45**	**3.85**

Helping Hands Community Garden

Final Report

Partner Organization: Dakota Prairies Resource Conservation & Development

Project Summary

A. Background for the initial purpose of the project, including the specific issue, problem or need that was addressed by this project

The initial purpose of this project was to expand the production, distribution consumption of specialty crops on the Standing Rock Sioux Reservation. Along with a growth in the production and availability of fresh, local produce, the project provided needed classroom and hands-on training and education activities to youth, families and elders. This benefitted hundreds of residents of Standing Rock Reservation, which is in a food dessert and lacks a culturally relevant, sustainable food production system that utilizes specialty crops.

B. Importance and timeliness of the project

Residents of the Standing Rock Reservation continue to suffer from higher rates of obesity, heart disease, diabetes and other health issues. Some of this can be attributed to a diet that does not include enough of the recommended fresh fruits and vegetables. By growing and distributing specialty crops in Fort Yates, those residents were able to obtain fresh locally-produced fruits and vegetables at an affordable price and add them to their diets. They were also provided instruction on how to cook or preserve the fresh produce. Because of the success with the initial community garden at Fort Yates, this project aimed to expand into three other reservation communities. Of particular interest was Cannon Ball, which suffers from the highest poverty rates in the country. By adding a farmers market that incorporates a "barter" system, many in the community gained access to fresh, locally grown specialty crops.

C. If the project built on a previously funded project with the SCBGP or SCBGP-FB describe how this project complemented and enhanced previously completed work

Through a work plan carried out under a SCBG in 2011/12, the Helping Hands Community Garden in Fort Yates was established. This project provided sustainability to the successful work in providing knowledge and skills related to producing, consuming and marketing fresh, locally-grown fruits and vegetables.

Project Approach

D. Briefly summarize activities and tasks performed during the entire grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Specifically, discuss the tasks provided in the work plan of the approved project proposal. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.

Project Activity	Who	Timeline
1. Present gardener/nutrition program to students in kindergarten through 12th grade for	Extension agents; Sitting Bull College instructors;	Ongoing through March 2014

one hour per month, including the after-school program students 1a.Farmers market/nutrition educational trainings	tribal elders; support personnel	
2. Develop plan for garden plots	RC&D; Extension; NRCS; NGP	January 2014
3. Purchase supplies and materials for project activities	Extension Service	Ongoing 2014
4. Develop and distribute project promotional materials to local communities	Extension Service; RC&D	February 2014
5. Host a "Spring Gardening Workshop" kick-off campaign for the project	Extension; RC&D; NRCS; SFMNP; NGP,SBC	March 2014
6. Build tunnel greenhouse; purchase and apply soil amendments	Extension; support personnel; volunteers	March and May 2014
7. Plant specialty crops and take care of all management requirements (weeding, fertilizing, watering, etc.)	Extension; NGP; SRF, Long Soldier District; youth and adults (including tribal elders and garden plot producers)	May through December 2014
8. Growing season gardening (planting, maintaining, harvesting, processing, preserving, marketing	Extension agents; SBC, NGP, support personnel; youth and adults (including tribal elders and garden plot producers)	May through December 2014
9. Farmers markets, with education provided on how to grow and process the fruits and vegetables	Extension; producers; SFMNP, NGP; Long Soldier District; SRF	June 15, 2014, to Oct. 15, 2015
10. Fall Harvest Results Festival	Extension; schools, SR Farms	October 2014

First quarter: Jan. 1 to March 31, 2014

Sue Isbell, the Sioux County Extension Service agent; Cindy Dunn, administrative assistant; and Sam Rough Surface, the project's Fort Yates garden director, held several planning meetings to discuss and work on developing a 2014 growing season plan for the various garden plots in Fort Yates. In addition to the four high tunnel greenhouses already established behind the offices of the Sioux County Extension, there is a large garden plot near the Church of Jesus Christ of Latter-day Saints located several blocks to the south of the Extension office.

Among the many decisions made were where to put what crops; what varieties and quantities to use; how much new soil is needed and where; and what garden supplies are needed.

Susan Davis, the new executive director of Dakota Prairies RC&D Council, worked closely with Isbell and her team on planning activities and developing promotional materials.

Dunn and Rough Service conducted inventories of what office supplies and garden supplies were available and what needed to be ordered for the 2014 garden project. Following these detailed

inventories, Dunn and Isbell conducted ordering in March and April. Items ordered included shade cloth, a 6-foot staging table, plant rings, plant spirals, a Vanlet watering system, an elevated cedar raised garden bed kit and a 50-gallon rain barrel.

Although the "Spring Gardening Workshop" kick-off event was not held due to the cold weather, informal training took place wherever small groups were gathered.

Work during this first quarter included ordering and constructing a small greenhouse for the Solen school project work. The small Juliana basic model greenhouse is 6'6" wide by 7'4" long by 6'6" high. It features an aluminum frame with gutters and 4mm twin wall poly panels.

Isbell also met with the Solen school administrators (superintendent and principal) and the two school's two cooks. The discussion with the cooks focused on what to plant that they can use to serve the students. Most of the items they want to see planted involve typical salad bar vegetables such as cucumbers, lettuce, carrots, radishes and tomatoes.

Planting is ahead of schedule, thanks to the previously purchased and erected greenhouses and the new small greenhouse for Solen. Sam Rough Surface conducted garden preparation work that included getting the compost barrel ready; working on raised beds; maintenance on some of the existing garden boxes; cleaning up garden paths; raking between garden boxes; and cleaning the garden shop.

In addition, Rough Surface prepared the soil and planted cold-weather vegetables in one of the three smaller greenhouses near the Extension Service building. Crops planted include radishes, lettuce, beans, peas, cabbage, tomatoes and cucumbers. This greenhouse provides cold temperature and wind protection from the two greenhouses on the south and north sides of it and the larger high-tunnel greenhouse on the west side. In addition, Isbell has planted variety trials of 10 tomatoes plants and 10 pepper plants.

Isbell also started work on a plant breeding project (bush variety) on the outdoor 10-foot by 70-foot garden plot just north of the Extension Service office near the Church of Jesus Christ.

Second quarter: April 1 to June 30, 2014

Because of the late start on this project and now with no classes being held during the summer, training and education is being carried out on a more informal basis that is convenient and productive for both presenter and learners. Isbell performed general education this quarter by talking to children and adults where they were gathered for other events. Educational information shared this way has included the best cool and warm weather crops and how to plant and grow them.

To demonstrate this information, Isbell has shown seed packets and explained how to read and understand the germination information listed on them. Many times, reservation residents are not aware of seed and planting basics, so she demonstrates reading and understanding seed packets. This learning includes when to plant the seeds, how to plant the seeds and the growth time. By reaching these children and adults who are already gathered in small groups for community and other meetings, she can also share other gardening information with them, such as: 1) Soil and

what you need for good growing, such as nutrients and micro-organisms; 2) the value of worms to the soil; 3) how often to water and avoiding over-watering; 4) the cost comparison on starting seeds inside vs. buying bedding plants; and 5) the nutritional value of eating fresh fruits and vegetables.

Isbell was a presenter during the April 25, 2014, Sitting Bull Community College Sustainable Agriculture Conference. She presented a session on the value of gardening. The event was sponsored by Sitting Bull College and the USDA National Institute for Food & Agriculture. About 45 to 50 people attended the event.

In addition, Isbell and Dunn prepared education materials to hand out during the Fort Yates Farmers Market, which begins July 16 and will be held weekly until late fall. This will include nutrition information for the elderly, as well as recipes for produce to make it easier to cook and eat the nutritious fruits and vegetables.

Isbell, Dunn and Rough Service held several planning meetings this quarter to discuss and work on developing a garden plan for Solen. The cooks are still interested in using fresh vegetables for the beginning of this year's school year.

Dunn and Rough Service both conducted new inventories of office and garden supplies. New items ordered during this quarter included raised garden beds; additional soil; small equipment; and plants.

Dunn did extensive research on effective marketing flyers designed and distributed farmers market flyers to a wide audience. To reach the Standing Rock Reservation's American Indian population, she distributes the flyers to KLND Radio, the tribal radio station, as well as throughout each district. She also has an extensive Listserv she uses to distribute the flyers by e-mail and is making sure flyers are posted in the reservation communities of Cannon Ball, Fort Yates, Solen, and Selfridge in North Dakota and in Kenel in South Dakota.

Although the "Spring Gardening Workshop" kick-off event was not held, this project has become a true source for gardening for the entire reservation area. It is also drawing people from both inside and outside the area to learn more about it and to pick up tips on seeds, fertilizer, high-tunnel greenhouses, raised garden beds and much more.

Various groups that have been given tours of the gardens during the duration of this grant program represent about 250 people. They include: 1) USDA Rural Development-North Dakota; 2) First Lutheran Church, Fargo; 3) NDSU Extension staff (multiple groups); 4) Sitting Bull Community College; and 5) Standing Rock Sioux tribal members.

Because of the success of the Helping Hands Community Garden, it has become a place people come to help make choices about their own gardens and their own high-tunnel greenhouses. Miles McAllister and Sitting Bull Community College are just two of those planning their own high-tunnel greenhouses on the reservation, and have been in frequent contact with Isbell.

High-tunnel greenhouse work during this second quarter included purchasing a small greenhouse to start plants in at Solen.

Planting and gardening tasks this quarter involved researching the best seeds and then securing seeds and planting the bulk of the specialty crops. This has been followed by attentive care of the germinating and growing plants. The produce is all growing quickly and will soon be ready to harvest and sell.

Dunn spent time during this quarter to do extensive online and phone research on the best vegetable seeds. She also spent time finding the best garden hoses, fertilizer and other garden supplies and conducted an inventory of the garden tools. She also researched best ways to compost and shared the information with Rough Surface and Isbell.

Dunn also researched and ordered two Samsung tablets to be used for garden photos, inventory, planting dates and other uses. In addition, Dunn conducted online learning and designed farmers market flyers to distribute via e-mail and posting at reservation communities.

During this reporting period, Rough Surface planted and cared for produce that includes melon, cucumbers, squash, lettuce, beans, peas, cantaloupe, potatoes, tomatoes, beets, carrots and radishes.

Rough Surface has spent numerous hours watering and weeding all the regular specialty crops, of which some are nearly ready to be harvested. He also continues to work on the raised beds and spent time this quarter keeping the garden paths clean, raking between garden boxes and adding nutrients to the soil as necessary.

Other work Rough Surface has performed this quarter includes: 1) High-tunnel greenhouse repair; 2) weeding; 3) yard work; 4) soil preparation; 5) mowing; 6) hauling soil; 7) planting flowers; 8) plant transfers; 9) trim tomato plants; 10) thin carrots and radishes; 11) picking squash and cucumbers; and 12) garden tool cleaning and sharpening.

The Saskatchewan cherry bushes are starting to produce for the first time. And it appears that an abundant apple crop will be enjoyed after having the trees properly pruned.

The sunchokes, a root vegetable, are also growing and producing well. These provide great nutrition, especially for the elderly, when used as a substitute for potatoes. Also called "Jerusalem artichokes," sunchokes are reported as a folk remedy for diabetes. Sunchokes contain about 10 percent protein, no oil, and little starch. However, they are rich in the carbohydrate inulin (76 percent), which is a polymer of the monosaccharide fructose. Tubers stored for any length of time will convert their inulin into its component fructose. Jerusalem artichokes have an underlying sweet taste because of the fructose, which is about 1½ times sweeter than sucrose. Sunchokes are promoted as a healthy choice for type 2 diabetics because fructose is better tolerated by people who are type 2 diabetic.

In the trials of the 10 pepper varieties and the 10 tomato varieties, all germinated fairly well and evenly. However, one of the Rutgers tomato plants appears to be non-producing.

On the squash breeding project, all 40 hills that were planted are all up and at the three stage or greater. When able to determine which are vining and which are bush, Isbell and others will remove all the vining plants. The bush varieties will be saved for further plant breeding and evaluation.

Third quarter: July 1 to Sept. 30, 2014

Training and education continued to be carried out on a more informal basis, with Isbell and others sharing gardening and nutrition information with children and adults where they were gathered for other events. At the Cannon Ball schools, Isbell held general conversations with students, teachers and parents on gardening techniques and how the Cannon Ball garden will be included in the school system. Interest was quickly growing among the schools staff and students and the Cannon Ball community.

A more formal educational event was held during September at a Standing Rock Nutrition for the Elderly Program Health Fair held at Cannon Ball. About 55 people attended this event. Isbell talked about the Helping Hands Community Garden project funded through the SCBG Program. Megan "Moon" Martin, who has been hired to assist with the SCBG project, presented information on the nutritional value of Jerusalem artichokes. Often called sunchokes by Native American populations, this root vegetable is also called "Lakota potato" and "Prairie potato." Isbell and Martin offered taste testing of the sunchokes being grown at the Helping Hands Community Garden site in Fort Yates. Partners for the event included the Standing Rock Diabetes Program, which did blood sugar testing, and Sitting Bull College, which promoted physical fitness and staying healthy.

Mary Jean Hunter, nutrition education assistant of NDSU's Expanded Food and Nutrition Education Program, provided food safety and nutritional information to about 75 each month during this grant during the monthly food pantry events on Standing Rock.

Taste tests were conducted on the 10 varieties of tomatoes and the 10 variety of peppers that are being grown in the smaller greenhouses at the Helping Hands Community Garden site. Sam Rough Surface, the garden director, tracked the viability of each plant and the production on each variety. All the varieties except one tomato are producing abundant peppers and tomatoes.

During this quarter, meeting and discussion were held with the newly-formed Standing Rock Food Sovereignty Coalition to help find out about and coordinate current and future food-related projects throughout the Standing Rock Nation.

Five small greenhouses were purchased this quarter. They will be assembled and located in four reservation communities to be used as "germination huts." These greenhouses, called the "Affordable Hobby Greenhouse," are 10 feet wide and 12 feet long. This commercial-grade greenhouse is one of the strongest on the market. It features four two-piece hoops and eight ground stakes and includes all bracing and hardware, including galvanized steel end walls. The 6-mil clear, UV-treated poly greenhouse film included comes with a four-year warranty.

The starter plants generated in these small greenhouses will go into the existing greenhouses and garden plots associated with the Helping Hands Community Garden project. First to be started in the small greenhouses will be vegetables, followed by ornamental and traditional plants that be sold into the Standing Rock Reservation communities. This will help make this project sustainable.
Another large purchase under supplies was 125 corrugated metal raised garden beds. Constructed with galvanized steel material, these will last much longer than the untreated plywood that is currently being used. The mixture of water, heat and soil has already rotten the wood boxes after only several years of use. Rough Surface has begun assembling the new garden beds that are each 42 inches long, 24 inches wide and 18 inches high.

The corrugated steel boxes are engineered to support the full weight of vegetation and soil. In addition, the extra height helps with root growth and helps keep moisture inside the planter boxes. An added benefit to the Helping Hands Community Garden project is that these new raised garden boxes will allow more room for plants as they can be set closer together in each of the high-tunnel greenhouses. The wood that is not rotten will be reclaimed and in the greenhouse construction.

Dunn designed and distributed additional farmers market flyers across the Standing Rock Reservation. Most flyers were distributed electronically to partners, communities and entities. She also distributed the flyers to KLND Radio, the tribal radio station, as well as throughout each district. Dunn has created an extensive Listserv to distribute the flyers by e-mail and made sure flyers were posted in the reservation communities of Cannon Ball, Fort Yates, Solen and Selfridge in North Dakota and in Kenel in South Dakota. The farmers market information was also listed on the Web page of the Sioux County Extension Service.

During this quarter, time was spent on relationship building, with a goal of securing more partners. Isbell, Martin and others participated in the newly-formed Standing Rock Food Sovereignty Coalition, which is a collaboration of many individuals and organizations. Its mission is: "Helping grow more fresh, local, culturally-appropriate foods to support the people and economy of the Standing Rock Sioux Tribe." The Web site of the Food Sovereignty Coalition is www.foodsovereigntyforstandingrock.com.

Isbell and others with the Helping Hands Community Garden have also been collaborating with the Sitting Bull College Extension Program, directed by Jackie Bigger, and the NDSU Extension Service. Other partner relationships include Sitting Bull College; the Standing Rock Diabetes Program; the Standing Rock schools and school districts; local businesses; and faith-based organizations.

Greenhouse work during this quarter included completing the erection of a small greenhouse to use as a "germination hut" to start plants in at Solen. Isbell also visited the Solen School cooks this quarter to gauge their continued interest in using fresh vegetables and fruits in the school lunch program. The cooks are still keenly interested in incorporating a variety of produce into the hot lunch program. Isbell and Martin plan to visit with the Rosebud Sioux Tribe's Youth Program, which is doing innovative garden projects with its youth.

Isbell and Martin also explored the idea of renovating an old root cellar built many years ago by the Civilian Conservation Corps. Root cellars were constructed in each of the reservation's districts. With some renovation, the root cellar in Cannon Ball could be used to store extra produce.

Much of the gardening work this quarter involved watering, weeding and thinning the growing vegetables. During this reporting period, Rough Surface cared for produce that includes melon, cucumbers, squash, lettuce, beans, peas, cantaloupe, potatoes, tomatoes, beets, carrots and radishes. Then, beginning in July, Rough Surface and volunteers harvested, cleaned and prepared produce for farmers markets every Wednesday in Fort Yates and every Friday at another Standing Rock district, including the Bear Soldier District, where elders had vouchers and needed fresh produce.

He also spent time keeping the garden paths clean, raking between garden boxes and adding nutrients to the soil as necessary.

Other work Rough Surface has performed this quarter includes garden tool cleaning and sharpening; cleaning and organizing the garden shed; mowing; harvesting apples; assembling a small greenhouse; and assembling corrugated steel raised garden boxes.

The Saskatchewan cherry bushes produced for the first time this year and—after having the apple trees properly pruned—there is a lush crop of apples that will be harvested and sold in late September and during October. Many of the apples were Sweet 16, which are good for eating, drying or baking.

A lot of attention and emphasis has been put on the growing sunchokes, a root vegetable. Most of this work has been performed by Martin. The plan is to work on ways to use these to help reduce diabetes as they are rich in the carbohydrate inulin (76 percent), which is a polymer of the monosaccharide fructose.

Sunchokes provide great nutrition as they contain about 10 percent protein, no oil and little starch. During this period, project staff used them to make shredded hashbrowns, coleslaw and other dishes to demonstrate that sunchokes taste good and can be used in place of potatoes.

Sunchokes stored for any length of time will convert their inulin into its component fructose. Jerusalem artichokes have an underlying sweet taste because of the fructose, which is about 1½ times sweeter than sucrose. Sunchokes are promoted as a healthy choice for type 2 diabetics because fructose is better tolerated by people who are type 2 diabetic.

Martin is starting to conduct experiments in dehydrating the sunchokes, after which she will grind and make into low-glycemic flour that could be used by everyone, but especially those with diabetes. Sunchoke flour tends to be heavy and dense so Martin will experiment supplementing it with cattail rhizome, a root starch. It is hoped that if these sunchoke flour trials are successful, it can replace wheat flour in the Standing Rock Commodities Program. This way, tribal members can make such things frybread out of sunchoke flour, improving the nutritional value of this popular food item.

Sunchokes are best harvested after the first frost, so most of this harvest will occur in October. Sunchokes also create tubers, so the plants can be aggressive and hard to rotate. This seems to have caused some sunchoke negativity with producers (but not with consumers). Because of their aggressive nature, the sunchokes were planted and are growing outside the high-tunnel greenhouses on a small patch of land near the back fence of the Helping Hands Community Garden site.

During the drying trials she has been conducting, Martin is finding that the timing and size of trays are critical in the sunchoke dehydration process. The dehydrated sunchokes may also be used in a packaged dry soup mix for use on the reservation.

Martin also spent some time contacting elders about capturing their stories on traditional Native foods and the health benefits of them.

In the trials of the 10 pepper varieties and the 10 tomato varieties, all the plants are healthy and lush. All are bearing produce except one of the Rutgers tomato plants.

On the squash breeding project, Isbell and others have removed all the vining plants, leaving only the bush varieties that will be used for further plant breeding and evaluation.

The squash in the F2 cross breeding project of Hubbard and Gold Nugget squash are of varying shapes and colors and are producing well. The winning squash is this youth squash breeding project is a small, deep-orange-color squash that has been named “King Cody” after Rough Surface’s grandson, Cody. The youth wanted a small squash that would be easy to use in soups or small meals. It has the orange coloring like Gold Nugget, but tough skin like Hubbard. The shape is most similar to Gold Nugget, only smaller. The King Cody squash is dense in fiber and very flavorful. It cooks well and is great in soups. This bush variety takes up less space and its smaller size makes is more usable. Isbell with work with Frank Kutka, the Farm Breeding Club coordinator for the Northern Plains Sustainable Agriculture Society, to evaluate the squash cross breeding project and the resulting King Cody squash.

The first farmers market was held July 16. The weekly farmers market in Fort Yates was held each Wednesday on Main Street. A second weekly farmers market was also held in other Standing Rock districts every Friday, due to need and demand.

During the first farmers market at Fort Yates, the produce sold out in less than two hours. In high demand at the farmers markets were onions, cucumbers, tomatoes, peppers, potatoes, carrots, green beans, peas and squash. The estimated $2,000 to $2,500 worth of produce that was grown was either sold or distributed free to families and elders in the Standing Rock communities. Elderly tribal members were able to obtain fresh fruits and vegetables through vouchers distributed through the Standing Rock Nutrition for the Elderly Program.

Some sort of education was a component of every farmers markets. Most was informal information shared in visiting. Other information was recipes and nutritional advice. There was

also taste testing of the 10 trials for tomatoes and 10 trials for peppers, as well as sunchoke taste testing and recipes.

Rough Surface and volunteers spent many hours watering, weeding, raking and thinning the growing vegetables this quarter. They also worked to harvest, clean and take to market the vegetables grown in the greenhouses at the Sioux County Extension Service site. Most produce was sold by the pound, so there was bagging and weighing involved. Fruits harvested and sold or given away included apples and wild fruits such as plums, grapes and chokecherries.

Because of the growing demands for more fresh, local produce, Isbell has begun discussion with Standing Rock Farms on the idea of using any available land it may have. The irrigation pivots used on Standing Rock Farms creates some unused corners, and this land may be able to be used to plant additional carrots, potatoes and squash in each of the reservation's districts. This produce would go back to the local communities to help supply fresh, nutritional produce to families and the elderly who otherwise may not have any. Isbell will continue discussions with Standing Rock Farms and explore other possible land to expand the amount of produce that can be grown.

Planning for the Fall Harvest Festival was begun this quarter, with the event scheduled for Oct. 24 at Fort Yates. Martin is leading the planning of this event, which is anticipated will include a traditional foods potluck dinner and sunchoke taste testing.

Fourth quarter: Oct. 1 to Dec. 12, 2014

Jessie Barber, an AmeriCorp VISTA volunteer who had previously worked for the Standing Rock Nutrition for the Elderly Program, joined the Helping Hands Community Garden program during this period. He will focus on building partnerships for the program, as well as education and mentoring. As part of his job with the VISTA program, Barber was working to help install community gardens in each of the eight Standing Rock districts. As a result of this, he found out about the Helping Hands Community Garden project, as well as other projects dedicated to increasing access to healthy foods on the reservation. These included the planned SBC micro-farm and the GMG sustainable community development project. What was missing was coordination and communication between these garden projects. Impromptu meetings between these groups and others soon grew into the new Standing Rock Food Sovereignty Coalition.

Barber is now taking a lead role in the new Food Sovereignty Coalition, which meets at least once or twice a month. This grassroots entity is a loose network of individuals and organizations working to empower the tribe and increase food access on the reservation. This access was mostly lost during the flooding of tribal bottomlands to build dams. The Coalition's members hope to develop ways to make food sovereignty a reality for the people of Standing Rock once again. This will include efforts for environmental restoration and developing methods of food production that restore health to the earth rather than stripping it. Permaculture and studies of traditional methods have been great resources for this process.

The organization's mission is to advocate for sovereign and sustainable production and control of more fresh, local, culturally-appropriate foods to support the health and well-being of the people and economy of Standing Rock. Barber is the coalition's director and Martin serves as the secretary. The Standing Rock Nutrition for the Elderly Program and the Standing Rock Diabetes

Program, both strong partners of the Helping Hands Community Garden project, are also members of the Food Sovereignty Coalition. Other members include Indian Health Services, NDSU Extension, Sitting Bull College (SBC) Extension, SDSU Extension, GMG Associates, Tribal Visitor Center, Natural Law Institute, SBC Library, SBC Agricultural Department, local ethnobotanists, local teachers and community members.

Educational work included Isbell, Megan Martin and Jessie Barber dispersing gardening, cooking and nutritional information in small groups throughout Standing Rock Reservation. Where small groups are gathered, including at the grocery store, schools and community events, is an effective way to disperse information. In addition, people stopped by the offices at the Sioux County Extension Service in Fort Yates to get more information and have their questions answered. We estimate a total of about 1,700 were reached with information during the duration of this grant.

Isbell continued to attend the monthly Sioux County Commission meetings, where she shared updates on the Helping Hands Community Garden project and dispersed nutritional information. Attendance at each monthly meeting is typically five to six people.

Isbell met at the Sitting Bull Community College Dec. 10 to present an update on the Helping Hands project and discuss ways to partner on reviving a horticultural education program called the "Sunday Academy," which involved providing education to middle and high-school students. The program may be revised to work with students in grades three, four and five to engage them earlier in learning about the germination process. The curriculum could include every student planting a lima bean to grow and dissect. This will show them first hand that every seed contains an embryo, which could grow into a living plant. Also inside each seed is endosperm, a temporary food supply for the plant.

Isbell was a presenter at the Nov. 21-23 Fall All-Star Conference in Knoxville, Tenn. She shared information on the Helping Hands project to the high-schoolers in attendance. Her presentation drew a lot of interest and many questions were asked. There were about 130 in attendance.

Martin and Barber attended November events at the Pine Ridge and Rosebud reservations in South Dakota. The events featured restoration of gardening in Native American communities. They also met with the leader of the successful youth garden project on the Rosebud Reservation. In all, there were about 100 attendees.

Martin has begun work on a gardening/nutrition related curriculum to teach to students at the Cannon Ball school. She will meet with each class weekly to present scientific but culturally-relevant information.

Work was conducted to wrap up the gardening and farmers market projects. Rough Surface spent time harvesting the remaining crops and selling them at the farmers market. Once the harvest was complete, he pulled dead plants and removed the old rotten wood planting boxes and raked the garden areas. He spent time assembling the new steel boxes, which will be installed in the high-tunnel greenhouses in early spring. Rough Surface also cleaned all the tools and organized the storage shed.

Extra late fall crops, including potatoes and squash, were distributed to the Nutrition for the Elderly Program and to the schools in Fort Yates, Solen and Cannon Ball.

Martin continued to plan and organize the "Traditional Harvest Festival," which was held Oct. 24 at Fort Yates. About 50 residents attended the 3 to 6 p.m. event at the Mormon Church. About 12 to 15 people brought their favorite traditional food dishes to share for the free meal.

The cultural dishes included a buffalo stew (also featuring timpsila and Indian corn), Jerusalem artichoke hashbrowns, blue-corn bread, a deer roast, wojapi (berry soup) and "Indian corn" on the cob.

In addition to the free meal and visiting, extra fall produce that consisted mainly of potatoes and squash were distributed to participants.

Besides the Helping Hands Community Garden, other sponsors of the event included the Nutrition for the Elderly Program, the Standing Rock Diabetes Program, NDSU/Sioux County Extension, Sitting Bull College Extension and the Standing Rock Food Sovereignty Coalition. Several displays included one Jessie Barber created for the Standing Rock Food Sovereignty Coalition and an informational station on Jerusalem artichokes.

Dunn spent time researching and ordering supplies during this period. Among items ordered were 10 low-cost electronic tablets that will be used to conduct youth training and education. Martin, who is developing a gardening and nutrition-related curriculum, will use the tablets in the Cannon Ball school.

Students will use the tablets to learn the importance of researched-based information. Finding accurate, reliable information will be stressed as part of the curriculum. Students will also use the tablets to keep journals and take photographs of their garden-related hands-on learning.

Martin continued her work on Jerusalem artichokes and creating a low-glycemic four from them. She has been cleaning, cutting and dehydrating them. As part of her research, she looked at using

Isbell and Martin also continued general information on the benefits and nutritional value of sunchokes. They were a popular staple of American Indians before they were lost to flooding and cultural issue. Some tribal residents planted them this fall and some will plant this spring.

Martin also spent some time researching and studying prairie turnips (Psoralea esculenta). The Lakota word for this traditional Lakota food staple is timpsila/tinpsila. Most people within the community refer to them by this Lakota name or as turnips. They are a delicious complex-carbohydrate that offers a lot of nutritive value to Indigenous peoples.

Because it is an important traditional food, Martin wanted to include it in the harvest festival. A community member donated a braid of her dried timpsila to include in the buffalo stew, which was served. Before using, Martin snipped the turnips off their braided stalks and soaked them for 24 hours. She then gave them to the Diabetes Program employees, who cut them up and added

them to the buffalo stew.

Although it takes, on average, five years for a timpsila plant to come to maturity, Martin ordered and will plant new timpsila seeds as part of the Helping Hands Community Garden project. Five years from now, there should be a prolific amount of cultivated timpsila. And then, as long as new plants are seeded every spring, there should be a harvest of mature plants annually. These can be used for the traditional dehydrated soup mix that is planned for tribal members.

Fifth quarter: Jan. 1, 2015, to March 31, 2015

Martin spent time researching and creating a curriculum for the kindergarten through sixth-grade students at the Cannon Ball school. She then began implementing that specialty crop training and education program in January 2015.

Martin teaches at the Cannon Ball school three days a week on Mondays, Tuesdays and Wednesdays. While there, she conducts two classes each day. Each class is about 40 minutes long. The only grade she is not teaching this school year is the fifth grade, as they already had a similar class planned. The fifth-grade class will be added next year in place of the kindergarten students.

In all, this project has begun providing specialty crop training and education for about 85 Cannon Ball school students. This includes eight students in kindergarten, 15 in first grade; 16 in second grade; 22 in third grade; 11 in fourth grade; and 13 in sixth grade.

On Mondays, Martin works with the second- and third-grade students. On Tuesdays, those in kindergarten and sixth grade participate. And on Wednesdays, Martin teaches first- and fourth-graders.

The four-part lessons Martin is teaching focus on: 1) Seeds and roots; 2) stems; 3) leaves; and 4) flowers.

Seeds was a two-part lesson. The focus was on respect for seeds as without them we would not have food. They are our life source. Also, students learned what to expect when a seed is planted. During this period, Martin also started a food composting and recycling initiative and is working on establishing a school garden directly behind the Cannon Ball school.

The main recycling bin is located in the Culture Class. Then, each class has a compost container and a different bins for plastic, paper and compost. Plastic snack cups will be used to start plants. Martin is currently emptying the individual classroom bins into the main one, but students are being taught to perform this function. This is giving them knowledge about recycling and composting.

The school garden being developed by Martin is offering Cannon Ball students hands-on learning on how to grow and care for specialty crops. And although there is no summer school planned this year, Martin is encouraging students to drop by the school to help work on the outdoor garden and learn more about produce production.

Other work Martin performed this quarter includes researching and ordering permaculture books; educational garden books; educational supplies; a grow light; and garden curriculum. Martin also started a "garden club" for the Cannon Ball second- and third-grade students and attended and participated in the Standing Rock Food Sovereignty Coalition meetings.

In addition, Sue Isbell, the Sioux County Extension Service agent, is informally sharing gardening and nutrition information with children and adults where they are gathered for other events in Fort Yates and Solen.
Planning was done for the Helping Hands Community Garden in Fort Yates and the outdoor garden area at the nearby Church of Jesus Christ of Latter-day Saints.

Isbell is coordinating with the organic potato research team at the University of Wisconsin-Madison to conduct potato trials at the outdoor site in Fort Yates and at the new Cannon Ball garden site. Isbell will work with the organic potato research team at the University of Wisconsin-Madison to test new seed varieties. Soil testing will be conducted in April at both sites. Six varieties will be tested using both irrigated (Fort Yates) and non-irrigated (Cannon Ball) plots.

Planning has also been conducted on what specialty crops to plant and grow at both the Fort Yates and Cannon Ball sites. Brian Broken Leg, garden assistant, met with Isbell and other project members, to do some long-terms planning for the Fort Yates garden site. Broken Leg also participated in a handful of planning meetings on the Cannon Ball garden site.

Barber spent time this quarter implementing garden projects and educational programs. He attended planning meetings with Isbell and others, researched specialty crop needs at Cannon Ball and assisted Martin with educational programming at Cannon Ball. Berber receives no pay, but has some of his mileage reimbursed.

Martin, Barber and Katrina Wilke, a new Vista volunteer with the Sioux County Extension Service, attended a training event in early March in Callaway, Minn. The event, the 12th Annual Indigenous Farming Conference, provided a wealth of knowledge and information. The many topics included: Enjoy your homegrown food year-found with an energy efficient root cellar; indigenous permaculture; tribal college community garden programs; and ancient methods of food preservation and making medicines from the foods you grow. About 200 attended the event.

Besides the small school garden directly behind the Cannon Ball school, a garden is being planned on tribal land about a half-mile east of the school. At least one large high tunnel greenhouse will be ordered and erected (through SCBG 14-217) at this site during the next quarter. The site is where the old root cellar, built during the 1930s, is located on a bluff overlooking the Missouri River.

The remaining garden supplies and office supplies were ordered during this quarter. This included 50 garden beds were ordered from Carrier Security Corp. The Sendero garden beds are constructed with galvanized steel material that is both attractive and UV resistant. At a height of 18 inches, each Sendero garden bed provides the depth needed to promote superior root growth of vegetables, herbs and more.

During this quarter, time was spent on relationship building, with a goal of securing more partners.

Because of poor weather, the "Spring Gardening Workshop" kick-off event was not held during March 2014 as planned. To make up for this, Isbell is planning a special Earth Day Festival on April 22 at Fort Yates and Cannon Ball. Invited and expected to attend are staff from USDA Rural Development-North Dakota. A tour of the SCBG community gardens in Fort Yates and Cannon Ball are planned.

Sixth quarter: April 1, 2015, to June 31, 2015
Final work included this project's team attending and participating in the April 17 and 18 Dakota Garden Expo at the Civic Center in Bismarck. Isbell presented a demonstration called "Starting Seeds in Soil Cubes." Assisted by her team members, Martin, Barber and Wilke, she discussed the best practices and cost effectiveness of starting seeds in soil cubes. Each participant received one soil cube to take home with them. Soil cubes are less expensive than commercially-produced starting pods. They can also be made larger to help eliminate transplant shock. During the Dakota Expo, Isbell also visited with other producers and learned about other successful ideas. These will be implemented at the Standing Rock gardens to help enhance the production of specialty crops.

About 15 attended the soil cubes demonstration. The session was videotaped so it can be used to educate others in the future.

Isbell continued to coordinate with the organic potato research team at the University of Wisconsin-Madison to conduct potato trials at the outdoor garden area at the Church of Jesus Christ of Latter-day Saints in Fort Yates. Isbell led the work on the planting of the new potato seed varieties.

Susan Davis, executive director of Dakota Prairies RC&D Council, Bismarck, spent time reviewing project plans and touring the garden sites in early April 2015. She also helped with budgeting the remaining grant funds and conducted reporting functions.

Isbell organized and a special "Standing Rock Earth Day Festival." Held April 22, the event included tours of the SCBG-funded garden sites at Fort Yates and Cannon Ball. The estimated 225 attendees included school students, parents, tribal Elders; educators and community members. Also attending were staff from USDA Rural Development-North Dakota, including Bill Davis, interim director.

The event began at the Cannon Ball School, where guests helped about 100 elementary school students produce soil pods and placing seeds in them to start the garden project directly behind the school. Isbell presented an overview of the garden project by discussing its goals and implementation plans. She explained that the plans to incorporate the Cannon Ball historic root cellar in the plans to provide fresh fruits and vegetables to the community.

After touring the school and community garden sites in Cannon Ball, the USDA Rural Development staff and others traveled to Fort Yates to look at the two garden sites there. They visited bot the high tunnel greenhouses behind the offices of Sioux County Extension Service and the nearby outdoor garden.
This April 22, 2015, Earth Day event, was held to replace the Task 5 "Spring Gardening Workshop" that was not held due to poor weather.

Throughout the day on April 22, Isbell discussed the idea to seek additional funds to incorporate solar power in the high tunnel greenhouses. Katrina Wilke, a Vista volunteer, has been conducting extensive research in the potential to incorporate solar energy in all the garden projects. Tribal Chairman Dave Archaumbault II, has a keen interest in a small-scale research that will show which of three gardening methods would best fit the climate on the Standing Rock Reservation. They are:

1. Using shipping containers combined with solar energy
2. A walipini, an in-ground production facility
3. An above ground all-season greenhouse

Seventh quarter: July 1, 2015, to Aug. 31, 2015
The final work performed during this final quarter of this project was the community survey. The one-page survey instrument was designed and created by Susan Davis, with input from Petra Reyna One Hawk. One Hawk used the completed survey instrument to conduct in-person interviews with 50 members of the Standing Rock Sioux Tribe during July and August 2015. *(See the full survey results under Section J)*

E. If the overall scope of the project benefitted commodities other than specialty crops, indicate how project staff ensured that funds were used to solely enhance the competitiveness of specialty crops

The project benefitted only specialty crops.

F. Present the significant contributions and role of project partners in the project

■ **Sioux County Extension Service**: Sue Isbell, director of the Sioux County Extension Service, served as the project director, assembling a talented team to help conduct the hands-on work. This office is where all the flyers and media releases were generated and the project staff was housed.

■ **Nutrition for the Elderly Program**: This USDA-funded program provided the vouchers to the elderly of the Standing Rock Reservation through a grant program. Nutritional farmers market vouchers to buy fresh produce. Without this program the elders would not have cash available to purchase or consume these fresh, locally grown specialty products in the Fort Yates area. During the 2014/15 growing season, more than 3,000 had been issued as of Aug. 31, 2015.

■ **Standing Rock Diabetes Program:** This department provided an education component on healthy eating and encouraged program participants to attend the Fort Yates farmers markets to get fresh specialty products.

■ **Sitting Bull College**: This tribal college located in Fort Yates put in a garden this year and is a vendor at the Fort Yates farmers markets. This helps provide a wider variety of produce. This also provided another education opportunity as the college incorporates farmers market and other education in its marketing and ag classes. Sitting Bull College also provides education to the wider community.

■ **Tribal Historic Preservation Office**: This Standing Rock Reservation office helped with the historical aspect of gardening, especially as it relates to the Cannon Ball root cellar that was built in the 1930s. It also helped secure the use of the historic root cellar at the site of the new community garden in Cannon Call.

■ **North Dakota State University (NDSU) Master of Public Health Program:** Dr. Donald Warne of NDSU has been a valuable resource on nutritional and cultural information. He is the director of the Master of Public Health Program and served as the senior policy advisor to the Great Plains Tribal Chairmen's Health Board. He is an expert on Native American health disparities.

■ **Cannon Ball school:** The staff at the Cannon Ball school provided the location of the school garden and offered the opportunity to conduct training and education at the school during the 2014/15 school year.

■ **Standing Rock Sioux Tribe:** Tribal Chairman Dave Archaumbault II supports the overall project and has held several discussions with Isbell.

■ **Bureau of Indian Affairs:** This agency worked with Isbell to secure the location for the community garden east of the Cannon Ball school.

■ **NDSU:** The North Dakota NDSU Extension Service provided support to the local Sioux County Extension Service and the opportunity for this project to take a different path to serve this unique community and project.

■ **Sioux County Commissioners**: The Sioux County Commission provides the location of the Helping Hands Community Garden high tunnels in Fort Yates and provided a used pickup for Sue Isbell, the project leader. It also provides operational support.

■ **Church of Christ of Latter-day Saints**: This large outdoor garden location is owned and donated by the church. This allows the project to operate a second garden free of charge. Church of Christ leaders also provide produce production work at no charge and donates all the produce back into this program.

■ **KLJ Engineering**: Staff from Bismarck and Fargo provided a free structural assessment of the Cannon Ball root cellar and is providing site cleanup and root cellar repairs.

■ **Local community members**: Many members of the Standing Rock community provided volunteer labor and donations to the project.

■ **USDA Rural Development-North Dakota:** Bismarck staff members provided advisory services, especially with the development and future planning for the school and community gardens in Cannon Ball.

Goals and Outcomes Achieved

G. Activities that were completed in order to achieve the performance goals and measurable outcomes identified in the approved project proposal or subsequent amendments

The main activities that were achieved under each of the two main goals are as follows:

■ ***Goal 1, Increase the knowledge of specialty crops:*** One of the major activities completed under this goal is developing and administering a training and education program at the Cannon Ball Elementary School on the Standing Rock Reservation. Megan "Moon" Martin created classroom studies that featured a four-part lesson: 1) Seeds and roots; 2) stems; 3) leaves; and 4) flowers. Through this project, each of the 110 students planted at least one plant and tasted at least one new specialty crop they had not previously eaten. Cannon Ball students also received hands-on training and education as they helped start and care for the garden directly behind the school. This provided the students, as well as their family members and others in the community, an opportunity to learn how to plant, nurture, harvest and cook and eat specialty crops.

In addition, we planned and held a "traditional Harvest Festival" Oct. 24, 2015, that drew 50 residents and successfully shared information on seeds and planting to at least 500 residents of the Standing Rock Reservation. This informal way of teaching proved to be the most successful way of reaching the reservation's residents. By finding and talking to small groups already gathered for other events, we were able to share information quickly and inexpensively.

We also continued to share cooking and nutritional information during the established farmers market in Fort Yates and carried this over to the new "Barters Farmers Market" in Cannon Ball.

There are about 4,000 Standing Rock Sioux tribal members who live on the North Dakota side of the reservation. Of this number, we estimate we provided about 3,000 of them some sort of specialty crop training and education. Although we did not compare their specialty crop knowledge before and then after this program, a survey we conducted during the late summer of 2015, showed that 76 percent of those surveyed received effective specialty crop training and education in the form of produce growing, nutritional or food preparation or cooking information.

■ ***Goal 2, Increase the sale and accessibility of specialty crops:*** Major activities completed were envisioning and then creating the school and community gardens at Cannon Ball.
The bare grass field behind the school has blossomed into a full-grown garden that is still providing an abundance of produce to the needy members of this community. The weekly farmers markets are conducted on a "bartering" system, which allows those without money to trade such things as garden weeding and watering for fresh, nutritious specialty crops. And despite school being out for the summer, at least three to five school-age children show up at the site every day to help with the gardening tasks and take home fresh produce.

Although the new community garden site just east of the school was not ready in time to produce any specialty crops during the 2015 growing season, most of the work has been done to prepare for next spring's specialty crops. The high tunnel greenhouse is being constructed and wooden planter boxes have been built on the east side of the fenced-in area. The historic root cellar, after being assessed and deemed safe to use, has been cleaned out and painted and is ready to store extra specialty crops such as potatoes.

This school and community gardens at Cannon Ball have attracted the interest of USDA Rural Development in Bismarck and Washington, D.C. Max Finberg with the Cultural Transformation Initiative and StrikeForce Initiative for Rural Growth and Opportunity Program toured the Cannon Ball school and community gardens Aug. 5, 2015. He was accompanied by staff from Bismarck's USDA RD office, including then interim director Bill Davis. Finberg is now coordinating a vision session for the Barack and Michelle Obama Community Wellness Center in Cannon Ball that could include a food hub, commercial kitchen, and nutrition and education space. Finberg is also arranging a visit by Ed Avalos, undersecretary for marketing and regulatory programs, at USDA Rural Development in D.C.

We estimate that about 3,350 people obtained fresh produce at the farmers markets held during 2014 and 2015 in Fort Yates, McLaughlin and Cannon Ball. This is based on an average of 75 people attending the weekly farmers markets at Fort Yates; an average of 40 attending the weekly farmers markets at McLaughlin; and an average of 35 people attending the farmers markets in Cannon Ball.

Between the established farmers market in Fort Yates, the farmers market in McLaughlin and the new farmers market in Cannon Ball, we estimate that about 6 tons of specialty crops were grown, marketed or given away to those who needed it during the 2014 and 2015 growing season. Money was not always exchanged for the produce, but if a value of $1.50 per pound is figured for this estimated 12,000 pounds of produce, the total amount is $18,000. This figure also includes specialty crops grown and sold by other producers. The number of vendors at the Fort Yates Farmers Market continues to grow each year. This estimated value of $18,000 is up from the $16,425 that was estimated during the 2012 and 2013 growing seasons.

Many of those who obtained fresh produce at the farmers markets used tribal vouchers. The target for 2014 was 2,625 and we exceeded that with about 3,000 vouchers. In 2015, another estimated 3,000 vouchers were used to purchase the locally-grown specialty crops.

H. If outcome measures were long term, summarize the progress that has been made toward achievement.

The school and community gardens being established at Cannon Ball will create long-term sustainability of fresh local foods in this reservation community. The establishment of a community garden near an existing historic root cellar will serve as a pilot program that could mean sustainable community gardens at other Standing Rock Reservation communities. These root cellars were built in each of the reservation's districts in the 1930s by the Native American Conservation Civilian Corps. Although some might not be viable due to flooding and other damage, several other root cellars appear to be in remarkable condition. Some of these are located in reservation communities on the North Dakota side of the reservation, with at least one

identified on the South Dakota section of the reservation. The old root cellar at Bull Head, S.D., could allow this program to be extended into the South Dakota portion of the Standing Rock Reservation.

I. Comparison of actual accomplishments with the goals established for the reporting period.

This project had two main goals: 1) Increase knowledge of how to buy, grow and prepare specialty crops in communities of the Standing Rock Indian Reservation; and 2) increase the sale and accessibility of specialty crops for health-distressed communities on the reservation.

Accomplishments under goal 1 include providing some training and education to an estimated 76 percent of the residents in the Fort Yates and Cannon Ball/Solen areas. In addition to this number, some sort of hands-on or classroom training and education was conducted with all 110 students of the Cannon Ball Elementary School. Most of the adult residents of the reservation received training and education in small groups as they were gathered for community events or attending a reservation farmers market.

Under goal 2, we estimate that 6 tons of produce was grown and distributed during the 2014 and 2015 growing seasons. The bulk of this produce likely went to the reservation's elderly as an estimated 3,000 fresh produce vouchers were distributed and used during both the 2014 growing season and the 2015 growing season for a total of about 6,000 vouchers. This is up substantially from 2012, when 2,425 vouchers were used in conjunction with the farmers markets. We also believe there was an increase in the number of garden plots that produce local fruits and vegetables. In 2012, the baseline was 30 and the goal was to increase this number to 36. We were not able to track the actual number, so do not know if this target was reached. However, during the survey we conducted during August 2015, we found that 32 percent of those surveyed have a home garden.

One major change in this project's accomplishments was establishing a school garden at Cannon Ball rather than at Solen. However, Solen is still receiving a benefit as produce was used in that school's hot lunch program.

J. Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Baseline date that has been gathered to date shows that an estimated 2,600 pounds of specialty crops have been harvested and distributed during the 2015 growing season to date.

In another baseline data measure, 3,000 vouchers were distributed to the elderly of the Standing Rock Reservation during the both the 2014 and 2015 growing seasons. These vouchers were used at the farmers markets held on the reservation. This represents a 24 percent increase from the 2,425 vouchers that were used during the 2012 farmers markets.

In addition, a community survey conducted by Petra Reyna One Hawk during July and August 2015, shows strong support for the community gardens on the reservation and an increase in the amount of specialty crops available on the reservation. One Hawk conducted the one-page surveys in person with community members throughout the Standing Rock Reservation.

The results of the survey are as follows:

■ *Helping Hands Community Garden knowledge:* When asked if they had heard about the Helping Hands Community Garden and the resulting weekly summertime farmers markets, 35 of the 50 people surveyed (or 70 percent) said "yes" and 15 (or 30 percent) said "no." This shows the success of the marketing efforts, which were carried out through a wide variety of low-cost methods that included flyers, e-mails, announcements at events and one-on-on conversations.

■ *Farmers market attendance:* Although a majority of those surveyed have heard about the Helping Hands Community Garden, a smaller number than expected are participating in the resulting farmers markets. When asked if they have attended any of the weekly summer farmers markets at Fort Yates, only 34 percent answered "yes." The remaining 66 percent answered "no."

■ *Farmers market location:* The farmers market events are held on Main Street in Fort Yates, which is proving to be a convenient, popular location. The new farmers markets in Cannon Ball were initially held at the school, but have now been moved to near the Post Office and Community Center. Of the 50 people participating in the survey, 40 (or 80 percent) said the like the location of the farmers markets they attend. Of the remaining 10 respondents, 5 said no; 4 did not answer; and 1 was not sure.

■ *Another farmers market location:* Those surveyed were also asked if another location for a farmers market would be helpful. A total of 44 percent (22 participants) responded "yes" and 34 percent (17 participants) responded "no." Of the remaining 22 percent of the survey participants, 9 had no answer and 2 were not sure.

■ *An increase in specialty crops:* The 50 surveyed were asked if the weekly farmers markets as the result of the community garden have increased the amount of specialty crops available in the summer and fall. Answering yes were 72 percent, followed by no with 20 percent. A total of 4 percent did not answer this question and 4 percent said they were not sure.

■ *Gardening is growing:* According to the survey results, the number of those gardening on the reservation is slowly growing. A total of 32 percent said they have a garden and 68 percent said they do not.

■ *Training and education:* This project's training and education efforts have been effective as evidenced in the answers to the question if they received any produce growing, nutritional or food preparation/cooking information. The majority, 38 participants (or 76 percent), answered yes.

■ *Where training and education was received:* As a follow-up question, the 38 participants who answered yes to receiving training and education were asked through which program, service or location they received information. The answers are as follows:

- Farmers market: 18
- Commodity Program: 14
- Food pantry: 6
- EBT Program: 5

- Other answers and number of times they were listed: Friend, 3; NDSU Extension Office, 1; outside school, 1; and gardeners, 1

■ *Favorite farmers market products:* The 50 people participating in the survey were asked, "What are your favorite fruits or vegetables to get at the Fort Yates farmers market?" The open-ended question resulted in the following answers and the number of times they were mentioned:

- Cucumbers: 12
- Tomatoes: 11
- Peppers: 7
- Watermelon: 6
- Squash: 6
- Potatoes: 5
- Carrots: 3
- Kale: 3
- Green beans: 3
- Corn: 3

Other produce that was mentioned at least once included plums, cherries, rhubarb, peas, beans, broccoli, zucchini, peaches, apples, cantaloupe, celery, grapes, cauliflower, beets and raspberries.

■ *Specialty crops wanted:* When asked what fruits or vegetables that are not currently grown they would like to see added, respondents provided the following suggestions:

- Cherries
- More squash
- Workers are doing good. Whatever fruit they didn't grown they brought in for presentation
- Melons
- Brussel sprouts
- Herbs
- We have most now
- Small onions
- Variety of onions
- Fruit
- Spinach
- Cherries
- Strawberries
- Asparagus
- Watermelon
- Potatoes
- Potatoes, onions, lettuce, rhubarb
- Green beans
- Onions and watermelon
- Broccoli
- Berries
- Grapples

- Strawberries

■ *Community garden definition:* When asked for their definition of a community garden, survey participants had a wide range of answers that included the following:

- Living a healthy lifestyle through education, experience for our people.
- A place to meet and grow a garden.
- A garden spot where a number of people have their plots for their own personal growing.
- Experience
- Education
- Helping our people to be healthy
- Learning to be self-sufficient
- Helping our elders
- Everyone has a plot they are responsible for to plant and harvest
- Co-op. Everyone participating from beginning to end
- A garden which all the community participates in
- Community-involved gardening
- A garden where food is grown by and for the community
- Fresh veggies for everyone in the community
- Where everyone worked together to grow it and shared the produce
- Everyone benefits
- Everyone helps out to grow veggies and it helps out people
- Learning
- Everyone gains from it
- Great
- Eating healthy
- Awesome
- Working together, coming together and learning nutrition
- Helping people
- Gardens grown in community with community volunteers to operate it
- A garden for the local community for the people
- A great learning for the community
- Garden access to community (teaching kids as well)
- Fun food for all to share
- Somewhere all people can go and help and get fruits and vegetables
- Where everyone helps and shares
- A place where people get help with their nutrition
- Everyone working together
- People chipping in and planting and caring for the garden
- Everyone helps out
- Eating good

■ *Additional comments:* As the final question on the survey, participants were asked if there are any additional comments they would like to make. Responses included the following:

- I love the farmers markets during the summer. There are a lot of healthy choices which are delicious
- Hope this project keeps going
- Thank you
- Would like to see more people involved in selling vegetables at the farmers market
- I enjoy the markets and program a lot
- Very helpful in meal preparation
- Thank you for all your help
- Get more locations
- I like this where there's no fee.
- Great program. A lot of work goes into it. More volunteers are needed
- Great job. Keep it up. Proud of the program.
- Thank you for it
- Keep
- A great program that I hope to see expand

K. Highlight the major successful outcomes of the project in quantifiable terms.

One of the major successes of this project is the establishment of two garden sites at Cannon Ball, one of the poorest and neediest communities on the Standing Rock reservation.

From a bare field behind the Cannon Ball school grew a lush garden that is helping to feed members of a community who previously did not have readily or reliable access to fresh, locally grown produce. And because the majority of Cannon Ball residents live in poverty, no money is required to take home produce from the new farmers market there. Instead, a "barter" system allows residents to trade such things as garden volunteer hours. As a result, those who need the specialty crops are receiving and consuming them.

And rising from the banks of the Missouri River just to the east of the Cannon Ball School is a high tunnel greenhouse that will not only provide fresh local food, but will be used as an almost year-round educational facility. The greenhouse, erected immediately south of the historic root cellar, is set about 6 feet in the ground, which will allow the natural higher temperatures of the earth to extend the growing and teaching time. In addition, wooden grow boxes have been built outside in the fenced-in area. These, along with the high tunnel greenhouse, will be ready for spring planting in 2016.

An estimated total of 2,600 pounds of produce was grown and distributed during the 2015 growing season. Although the total pounds was not tracked during the 2014 growing season, it is estimated is was about 2,000 pounds, or a little lower than the second year. The second year was likely higher as the Cannon Ball school garden was created and a new farmers market established in Cannon Ball.

All 110 Cannon Ball students in grades kindergarten through sixth received training and education through this project. Not only did they receive classroom teaching in gardening and nutrition, they also received hands-on education. One-hundred percent of the Cannon Ball students planted a vegetable seed to take home with them and 100 percent also tried at least one new vegetable from the school garden. An average of eight to 10 students came to the Cannon

Ball school three days a week during a 10-week period during the summer of 2015. This resulted in a total of 80 to 100 youth continuing with their hands-on gardening training and education. It also provided them the opportunity to pick and take home fresh produce for them and their families.

To add more fruits to the specialty crop offerings in Cannon Ball, more than 250 fruit trees were planted at both the school and community garden sites. The fruit trees include pear, cherry apricot, apple, Juneberry and chokecherry.

Beneficiaries

L. Description of the groups and other operations that benefited from the completion of this project's accomplishments

■ Youth and families and community members of Standing Rock and specifically of Fort Yates, Solen and Cannon Ball.

■ Elders and community members

■ Reservation schools, especially the Cannon Ball school

■ Nutrition for the Elderly meal site (which does the Meals on Wheels for Fort Yates and Cannon Ball)

M. Clearly state the number of beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project

Youth, families, elders and other community members benefited from this project. It is estimated that at least 500 reservation residents and about 110 reservation students benefited from it one way or another.

Lessons Learned

N. Insights into the lessons learned by the project staff as a result of completing this project. (This section is meant to illustrate the positive and negative results and conclusions for the project)

Among the many lessons learned are the following:

■ It is difficult to maintain both volunteer and paid garden help. While volunteer help is important, it may be better to go with more paid help and increase the hourly rate to attract and keep more garden labor.

■ This project has shown that it is critical to know (through past history or new research) what specialty to grow and market. Rather than grow a little bit of everything, you need to plant, grow and market what residents want and what they will utilize. (For example, do not grow okra on the Standing Rock Reservation, as few knows what it is.)

■ Garden pest control needs to be proactive rather than reactive.

■ You cannot sell produce to people who have little or no money. However, people do not want to feel like they are getting a "hand-out" so set up some sort of "barter" system that allows them to trade for something. Most people have time and are interested in participating in the planting or growing of the sociality crops and want to feel a part of the project. This allows them to trade their time and expertise for fresh fruits and vegetables.

■ The location of a community's farmers market is important. It needs to be easily accessible for elders, children and others. The ground needs to be level and make sure there is a place for vehicles to pull into. Avoid any steps and set up at a site where folks already congregate for some reason, such as near schools (when in session), community centers or Post Offices.

■ Make your farmers markets a fun, comfortable place where people can sit and visit and share stories and/or recipes. Have some chairs (and possibly tables) set up.

■ Need someone to regularly provide taste samples during farmers market events. This will help sell produce and will also introduce people to specialty crops they have not tasted before. Along with this, need to share cooking instructions or recipes. The assumption is that everyone has experienced every fruit or vegetable, but that is far from the truth.

■ Need a good system to track quantitative measures such as how many pounds of produce are grown and marketed. It is hard to do without specific equipment. Software would be useful. Also, track every week to make it easier.

O. Describe unexpected outcomes or results that were an effect of implementing this project. Getting access to the historical root cellar in Cannon Ball was an unexpected but beneficial outcome. This root cellar that was built in the 1930s by the Native American CCC, will mean a wealth of fruits and vegetables will be able to be stored year-round at little to no cost. This is a tremendous benefit to the poverty-stricken residents of Cannon Ball.
In addition, the idea and approval to excavate a 6-foot hole in the ground and erect a high tunnel greenhouse over it, will allow the development of the Living Science Center at the Cannon Ball community garden site.

The rapid growth and popularity of the Cannon Ball school garden is also an unexpected outcome.

Another unexpected outcome of this project is the excitement and interest being seen from agencies outside of the project. For example, USDA Rural Development staff from North Dakota and Washington, D.C., have toured the Cannon Ball sites and are excited about the results and possible future growth. Max Finberg, senior advisor the assistant secretary for administration coordinator in D.C, visited the Cannon Ball garden sites in early August, along with Bill Davis, acting director for USDA Rural Development-North Dakota, and other staff. Finberg was so impressed with the Cannon Ball garden sites that he has arranged for undersecretary for marketing and regulatory programs, Ed Avalos, to visit the Standing Rock Sioux Reservation Oct. 1, 2015. His visit will include a stop at Cannon Ball to see the school and community

garden and hear the dream of the Barack and Michelle Obama Community Wellness Center, with a food hub, commercial kitchen, nutrition education space, etc. He will also see the farmers/barters market that day and school students will be at the garden. A grand opening of the root cellar will be planned for that day.

P. If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Lack of tracking measures were detrimental in reporting direct outcomes.

Q. Lessons learned should draw on positive experiences (i.e., good ideas that improve project efficiency or save money) and negative experiences (i.e., lessons learned about what did not go well and what needs to be changed).

As a result of the rapidly increasing demand for fresh specialty crops on the Standing Rock Reservation, it will be critical to conduct detailed gardening planning for next year's garden areas in Fort Yates and Cannon Ball. We propose to spend time over the winter to bring the garden workers and close partners together to discuss what should be planted and in which garden area it should be planted. Because driving distances can be great throughout the reservation, it will save time and money to not have to transport produce from one community garden to another.

We also plan to evaluate and put in place better ways to measure successes. Scales were not always available and not all project employees weighed produce. Likewise, the tomato trials conducted during the 2014 growing season were not thoroughly documented. This was partly the result of too little help and not enough time. We plan to research and implement some methods of tracking quantitative measures and make sure there are enough workers.

Contact

R. Name and contact person for the project

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Additional information available

S. Additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections

Updated flyers were created and sent out every week during the growing season to let people know of the farmers markets and what produce was available. These flyers are on file and are also posted on the Facebook page of the Sioux County Extension Service, which is https://www.facebook.com/SiouxCountyExtension

A wide variety of photos are available. Many are posted on the above listed Facebook page. Many are also on file at the offices of the Sioux County Extension Service and Dakota Prairies RC&D Council.

Ensuring Accessibility and Suitability of Vegetable Varieties: Ongoing Vegetable Variety Trials for Traits and Qualities Deeded by North Dakota's Market Growers

Final Report

Partner Organization: Northern Plains Sustainable Ag Society

Project Summary

- Background for the initial purpose of the project – With the rapid development of farmers markets, CSAs, and other local food production in North Dakota, there is an increased need for specialty crop varieties that fit our local climate and market demand. Crop varieties are important tools in food production, and variety choice is one of the most critical factors in gardening success. Variety trials provide farmers with relevant data that allows them to evaluate and choose varieties suited to their needs and the needs of their customers. Such trials are an underutilized risk management tool that can increase economic security of a farm and expand marketing opportunities by better fitting crops to local production systems and markets. The goal of this project was to increase the accessibility of garden crop varieties that are well suited to North Dakota by conducting variety trials.
- Importance and timeliness of the project – There have been few variety trials for specialty crops grown and sold by market gardeners in North Dakota for many years, even though there appears to be an expansion in sales and production. Market gardeners have not been a part of formal trials in a long time, and the inclusive aspect of our experimental design makes them a direct part of the process and expands connections among growers and our university system. There is interest among our partners at NDSU to restart formal specialty crop breeding and variety trials once more, and we hope that our results from this project will provide data and examples to support that interest.
- Describe how this project complemented and enhanced previously completed work – This project complemented and enhanced previously completed work by using additional growing seasons for the variety trials. The continuation of our first year study of specialty crop varieties helped to provide additional data and to get these results to the public at conferences and eventually via an Extension publication. Summaries from two years' worth of data provide a better understanding of how the varieties perform and enough data to begin identifying significant differences among the varieties.

Project Approach

- Brief summary of activities and tasks – Surveys of market growers. Surveys of audience members at NPSAS workshops, North Dakota Local Foods Workshops, and Bismarck Garden Expos were conducted in 2014 and 2015 to help identify knowledge of variety trials and their favorite garden crop varieties. We had 11 surveys returned from among our 35 plus audience members at the 2015 NPSAS Winter Conference in January, 2015 (total conference attendance of 625). Average scores were 3.8 out of 5 for increased understanding of variety trials, 4 out of 5 for whether variety trials were useful, and 4.2 out of 5 for adopting the varieties that appeared to perform better. Scores were around 3.5 for interest in taking part in variety trials, but really only 7 of the 11 reported interest

or strong interest in doing so. At the 2015 ND Local Foods Conference in Mandan, 19 surveys were returned from a workshop audience of about 30 (total conference attendance of 109). Sixteen of the 19 reported some or much increased knowledge about variety trials and ten reported an interest in conducting a variety trial. We had a larger audience at the 2014 ND Local Foods Conference in Minot, with more than 50 in attendance out of 105 attending the conference, but we only had 9 surveys returned. These growers shared with us their favorite specialty crop varieties. In April 2015, only 7 surveys were returned from an audience of 29 at the 2015 Garden Expo in Bismarck (total conference attendance in the many hundreds). Six reported a better or much improved understanding of variety trials, but only 2 reported an interest in taking part in them. An informal poll of NPSAS members and other specialty crop growers in April 2014 provided us a list of priority specialty crops. Nineteen growers submitted their top three crop species of interest. All this info was used in discussions to develop the second, two-state phase of our specialty crop trials.

- Brief summary of activities and tasks – Ongoing varietal evaluation training. We have conducted discussions of the project and our techniques at every FBC meeting since we started in 2013, and we include some explanation of how variety trials work at every presentation to the public (please see our talking points that are appended below). Some of these results have been described above. Holding meetings has worked okay with our collaborating market growers, but few are ever able to attend meetings at any one time. We tried a web meeting to enhance participation in March of 2015, and this added two more collaborators to the list of participants that day. We also have ongoing email contacts to alert everyone to the needs for data collection and field day presentation.

- Brief summary of activities and tasks – Source seed for trials. In February and March 2014 we ordered seeds of the same varieties we had evaluated in 2013, being sure to use the same sources as much as possible. Had some seed-borne disease issues, especially in beans, and this proved that some vendors were risky to use. Decided that seed sourcing would be best done in December or January in future work to avoid low supply issues and to make sure collaborators can start plants as early as they wish.

- Brief summary of activities and tasks – NDSU replicated trials. Dr. Lee and his students planted four replicates of each of our five crops (tomato, pepper, carrot, bean, cucumber). These did not flood out so badly this year, but there was ongoing trouble with rabbits that are notoriously hard to control in an urban environment. This caused the termination of the bean trial in 2014 due to extensive damage. Will require movable fencing in the future to allow completion of variety trials.

- Brief summary of activities and tasks – On farm trials. Our eight collaborators received seeds to plant one replicate each of two of our five crops (daughter sites). Continued to have problems with weather and disease in beans, but had more success with tomatoes and peppers generally. Lost some sites again this year due to flooding, high wind damage, spray drift, etc. It appears again that it is good to have more sites when it is affordable to do so to help overcome the risk of tough weather in North Dakota.

- Brief summary of activities and tasks – Field and tasting events. Our collaborators who had plots that could be harvested held nine field days or tasting events at their stands in 2014, several of which are highlighted in the videos we posted last year. NDSU also held a field day event and student tours of the plots into the fall (please see photos below). Some events had no more than 3 participants and one had over seventy. Given this experience we are considering holding just one or two big field days each summer in the future and then getting video at the other sites to post online in order to boost our audience. Of the 29 respondents at the Prairie Road Organic Farm Field Day on 2 August 2014, 25 reported better or much better understanding of variety trials and 13 said they were interested in taking part in variety trials. Of ten respondents at the Hiddendale Farm Field Day on 9 August 2014, six had a better or much better understanding of variety trials and two were probably or certainly going to take part in variety trials. Of the four respondents at the North Star Farms Field Day on 27 August 2014, all reported a better understanding of variety trials and two said they were interested in taking part in variety trials. Of the four respondents at the Tangle Tree Ranch Field Day on 28 August 2014, three reported a better or much better understanding of variety trials and two were interested in taking part in variety trials. Of the seven respondents from the Vig Farm Field Day on 30 August 2014, six had a better understanding of variety trials and none were interested in taking part in variety trials. Evaluations of crop varieties were not always at the ideal times (carrot evaluation in early August had to focus on top growth and vigor as the field day was too early for harvest) and did not always follow the presented protocols (tastings of tomatoes at farm stands and field days included the varieties that were mature at those times, but not all varieties). However, audiences in every case did notice differences among varieties when presented with them side by side, one of the most basic values of variety trials. Collaborators reported genuine interest in variety comparisons from the public, with some variation in the favorites chosen.

- Brief summary of activities and tasks – Compile and present data. NPSAS staff and NDSU graduate students collaborated on organizing and analyzing the data from our five species trials during winter of 2014-2015. This data was presented at the conferences named above and became the basis for the grower surveys already mentioned. The results handout that we used will be appended at the end of the report. NPSAS staff members have analyzed survey data as it comes in from the various survey sources. Results have been used in reports to ND Department of Agriculture and in discussions with FBC members and NDSU Plant Science faculty.

- Brief summary of activities and tasks – Video and other outreach. Video was shot during several field days in 2014 and again in 2015 by NPSAS staff. Finished videos were posted on YouTube (https://www.youtube.com/watch?v=N5cI4pi_2vM, https://www.youtube.com/watch?v=Edb5OAk1MiI, https://www.youtube.com/watch?v=8YqHbF9jZYY, https://www.youtube.com/watch?v=P4181Yzut3o). They have received 38-78 views each since posting/reposting. Our FBC Facebook page (https://www.facebook.com/pages/Farm-Breeding-Club/165221056860513) has had many postings about our specialty crops project and has been used to share results and to promote upcoming events. We currently have 815 likes for the page.

- The project did not directly benefit crops other than the five garden crops that we investigated. We hope others will borrow our approach for work on their specialty crops of interest, as the model is simple and appears effective with enough sites and seasons.

- Contributions and roles of project partners – Frank Kutka helped to organize activities, purchased seeds, led outreach, and collected information into project reports. Chiwon Lee led the trials at NDSU and helped with outreach. Zhigang Wu and other graduate students managed the NDSU trials and analyzed data for presentation. Collaborators Marvin and Ilene Baker, Annie Carlson, Sue Isbell, Steve Zwinger, Bill Bittle, Theresa Podoll, Karri Stroh, Darcie Webber, Marte Stensli, Glen Philbrick, and Travis Johnson planted and managed daughter variety trials and held public events, although some sites had to be terminated later due to flooding, hail, high wind, or spray drift.

Goals and Outcomes Achieved

- Measureable Outcome 1 – Increase the utilization of top performing vegetable varieties with documented performance. All of our activities throughout the project have been focused on this outcome as it is so very close to our overall goal. We have been expecting that 2/3 of the growers who hear about our results will adopt the better performing varieties. We were only able to begin showing much in the way of results in the winter of 2015, so we do not yet know about actual adoption. However, 7 of 11 surveys from the NPSAS Winter Conference, 11 of 19 surveys from the 2015 ND Local Foods Conference, and 5 of 7 surveys from the 2015 Bismarck Garden Expo showed an interest or strong interest in adopting the better performers. This is very close to 2/3 and we hope to hear more from growers in the winter of 2016.
- Measureable Outcome 2 – Gain farmer input and guidance for further cultivar improvement and development. The survey passed out to the 2013 NDFMGA and Local Foods Conference was a success (forty five responses from ninety seven attendees) and we were able to obtain input from growers about their interest in and opinions about thirty-nine specialty crops. They rated the crops by their current satisfaction with field performance and consumer traits and also by the importance of the crop to their operations. This information verified our crop choices for variety trials. Nine surveys returned from growers at the 2014 ND Local Foods Conference provided a list of favored varieties, traits in our five crops most needing improvement, and additional crops of interest beyond our five. The informal survey of growers via email in April, 2014 helped us to identify the crops of greatest interest among our nineteen respondents to help verify our current choices and to refine improvements in the second, two-state phase of our trials. Our expectation of 75% of audiences taking part in surveys was not realized, but we have been pleased with the very useful input we did receive.
- Measureable Outcome 3 – Increased knowledge of varietal differences, desirable quality traits, potential gains in varietal suitability, and the value of participatory variety evaluation. We have not been able to get a majority of our workshop and field day attendees to fill out and return survey forms. Despite this frustrating result, of those that did report, we have 86% reporting increased understanding of variety trials, which exceeds our expectation. Although audiences clearly saw value in the variety trials, with 82% of respondents saying the trials appeared useful or very useful for the crops we are

evaluating, only 39% of respondents have expressed interest in taking part in them with or without assistance. Our surveys for the last round of our project will include much more specific questions about each of these issues in order to better understand the valuing of variety trials but somewhat lower interest in direct participation.

Beneficiaries

- All gardeners and market growers in the region could benefit from the information we are developing. According to our records, we have benefitted at least 234 gardeners and market growers in the state through farm tours and conferences. Two years' worth of data is a very good start and we are building on this start with two more seasons of evaluations in the two-state, second phase of our project. We have been sharing the information via public meetings and field days for several years.
- Extension agents, horticultural researchers, plant breeders, and agriculture teachers could also benefit from the information we are developing. By identifying good varieties and desired traits, our findings could help guide future variety development in the state and the region, as well as provide useful information for other educators to share.
- Outreach from Jan, 2013 through August, 2015 included quarterly progress reports through the NPSAS Germinator with a circulation of @575 per edition; our FBC Facebook page has over 800 likes, and we have had several hundred views of our videos. We had >125 attendees at farm tours in 2013 and >100 attendees at our farm tours in 2014. We attended and distributed project information to 30-50 conferees at each of the following winter conferences: 2013-2015 NPSAS Winter Conferences with an attendance of @525 annually; 2014 Minnesota Organic Conference with attendance of over 500 in attendance; 2014 Organic Seed Growers Conference with 450 attendees, with 518 proceedings distributed; 2013-2015 North Dakota Local Foods Conferences with @100 attendees annually; 2014 South Dakota Local Foods Conference with >75 attendees; and 2015 Bismarck Garden Expo with many hundreds of attendees. North Dakota Living magazine ran an article on the diversity and growth of local foods, highlighting our project with distribution to >75,000 households.
- The potential economic impact of this project is dependent upon the identification and adoption of superior varieties for North Dakota. Variety trials across multiple seasons are the key to identifying superior performance and we have laid the groundwork for ongoing variety trials for 2015 and 2016. The 2014 variety trials marked a second season to overcome some of the weather disasters, implement our team experience and learning, and to provide additional data so that clear conclusions may be reached. This has provided growers with replicated results across multiple seasons with which to make informed varietal selections. Thus far we know that growers have expressed interest in adopting the better performing varieties from the current data set, but we will investigate further to see if they have actually made those choices and if benefits ensued.

Lessons Learned

- The primary difficulties faced during the years of 2013 and 2014 were bad weather, pests, and disease. These reduced our data set and caused the termination of some trials at some locations, especially the bean and tomato trials. NDSU is seeking to fence some of its

trial grounds to keep out rabbits, we have dropped some bean varieties that kept coming with seed borne disease, and we turned to having collaborators grow their own transplants in order to prevent the spread of Tomato Spotted Wilt Virus from older greenhouse facilities. Everyone working with us has been encouraged to plant on higher ground and to keep their plots well weeded. This said, our growers have generally continued to stay with the project despite the difficulties each season offers.

- Our collaborators generally are doing a great job, sharing info and photos, and putting on interesting field events. However, ongoing interactions with collaborators are at a distance and therefore not always as rapid as desired. For instance, in 2015 it took three months from the first request for field day dates to be set until the last events were scheduled, even with regular email communications. NPSAS is planning to be more formal with grower training, crop management, and reporting in the last year of the project with demonstration of experience before growers take part and one on one training when needed to be sure everyone fully understands the techniques and protocols.
- We have gotten plenty of interest and large audiences at our workshops, but getting written feedback from our growers and event participants continues to be difficult, and so far we have not been able to meet the goal of 75% reporting. There is just very little interest in filling out surveys, especially when folks are paying to attend workshops or are attending less formal, summer field events. NPSAS FBC staff will continue to emphasize the participatory nature of this project and to demonstrate how participant's feedback will be utilized to further project objectives. We hope that these will encourage more attendees to fill out and return surveys so we can better meet their needs.
- Getting data from growers and our NDSU partners went smoother in 2014 but could still be improved. We have encouraged timely data recording during the growing season and more shared updates among the group to make sure that data are well maintained and accurate and that all of the project team feels involved throughout the season. We are going to continue to demand reports before November so there is ample time to analyze the data for the winter conference season.

Contact

- Frank Kutka, NPSAS
  • Telephone Number – 701-225-7853
  • Email Address – fkutka@npsas.org

Additional Information Available

- Below we have appended photos and project handouts to document our work.

Lunchtime discussions of specialty crops during an FBC meeting in Medina, ND in 2013. NDSU's Chiwon Lee talks with expert growers Dwight Duke and Steve Zwinger.

NPSAS FBC Variety Trial Talking Points 2014 (For Field Day Leaders)

We want the best food for our customers and for eating ourselves. To get there we manage our gardens and fields to provide good growing conditions and hope for good weather, but another useful tool is good crop genetics.

The GENOTYPE is the combination of genes that a crop variety has. Some genotypes do better than others, so we compare varieties to try and identify the ones with the best genotypes so they are easy to grow and produce tasty food. The VARIETY TRIAL is the powerful tool we use for getting the best comparisons among the varieties. There is no better way to compare varieties than to grow them side by side as you see here. For our variety trials we are comparing ten varieties each of five important crops: green bean, tomato, pepper, cucumber, and carrot. Funding for this work has come to us from the USDA Specialty Crop Block Grants via the ND Department of Agriculture.

When a plant grows we see the results of two powerful, interacting forces. One is the GENOTYPE that provides the plant's capacity for production and the other is the ENVIRONMENT in which the plant grows. Because genotype and environment interact, some varieties will do better in some years, on some soils, and under some types of management better than others. This is the basis for adaptation. However, this interaction also means that we must be very careful when doing variety trials so we get the most useful information for ourselves and for the public.

What you see here for this crop is a single REPLICATE of our variety trial. There is a plot for each of our ten varieties all grown side by side in this set. We plant out the plots so that all of them are treated the same and on the most similar soil that we can. Then all of the varieties in the REPLICATE are growing under the most similar environment that we can provide. To help we also plant BORDER ROWS so that the plots on the edge are not getting advantages or suffering disadvantages because of that location.

We also plant additional REPLICATES so that the data we get is not too influenced by the results from any one field, location, or year. We have three farm growers each growing one replicate at their locations and Dr. Chiwon Lee at NDSU is also growing four replicates at his location. This is called a MOTHER-DAUGHTER EXPERIMENTAL DESIGN.

Another way to reduce the influence of environments on our results so that the effects of the genotypes are clearer is by using RANDOMIZATION. Within each replicate the order in which the varieties are planted is randomly determined. In this way no variety is always planted along an edge or in the middle, or always alongside another variety that might influence its performance.

By repeating the variety over several years and at several locations we can get a better feeling for how each variety will do on average over the environmental variation we will see here in North Dakota. This will help us to identify the varieties that are the most resilient and best performing. We will then share these data to help the public make the best variety choices they can for planting their own home and market gardens.

Vegetable Trial Field Day and Tasting
Department of Plant Sciences
NDSU

Time: 1:00-5:00 p.m., Friday, September 19, 2014

Place: NDSU Campus Field Plot
(Directly west of the new Research Greenhouse)

Please join us for an evaluation of the flavor and performance of vegetable crops grown at the NDSU campus field plot. Your participation in scoring produce quality is essential as we seek the best varieties for consumers and market gardeners. During this event we will taste test up to ten varieties each of carrots, cucumbers, tomatoes, and peppers. The ND Department of Agriculture supported this research with a Specialty Crop Block Grant and members of the Northern Plains Sustainable Agriculture Society have collaborated by growing similar research plots across North Dakota. For more information about this vegetable variety evaluation, please contact Chiwon W. Lee (701-231-8062, 701-361-9411 cell, or chiwon.lee@ndsu.edu).

Ensuring accessibility and suitability of vegetable varieties: Ongoing vegetable variety trials for traits and qualities needed by North Dakota's market growers
Preliminary Field Results, January 2015
Entrepreneurial Center for Horticulture (Dakota College at Bottineau), Fort Berthold Community College, North Dakota Farmers Market and Growers Association, North Dakota State University, and Northern Plains Sustainable Agriculture Society Farm Breeding Club

Green Bean

Table 1. Green snap bean cultivars evaluated in 2013 and 2014.

Cultivar	Seed source
1. Blue Lake 274	Irish Eyes
2. Bronco	High Mowing
3. Early Contender	Irish Eyes
4. E-Z Pick	Johnny's Selected Seeds
5. Jade	High Mowing
6. Provider	Johnny's Selected Seeds
7. Strike	High Mowing
8. Tendergreen	Irish Eyes
9. Top Crop	Measowlark Seeds

Table 2. Yield of nine green snap bean cultivars evaluated in 2013 and 2014.

Cultivar	Weight of pods (lb)[y]	% Avg. yield
1. Blue Lake 274	11.12 ± 4.12 a	93.53 ± 5.68 ab
2. Bronco	13.13 ± 3.91 a	122.99 ± 12.93 a
3. Early Contender	11.18 ± 3.3 a	95.71 ± 7.01 ab
4. E-Z Pick	9.75 ± 3.73 a	82.84 ± 6.05 b
5. Jade	12.03 ± 4.83 a	98.02 ± 17.49 ab
6. Provider	12.49 ± 4.02 a	112.12 ± 6.79 ab
7. Strike	12.05 ± 3.77 a	105.49 ± 13.24 ab
8. Tendergreen	11.20 ± 3.78 a	95.53 ± 6.54 ab
9. Top Crop	10.82 ± 3.79 a	94.11 ± 10.35 ab
$LSD_{0.05}$[y]	*3.50*	*31.59*

[y]Average weight of beans harvested from 10-foot row.

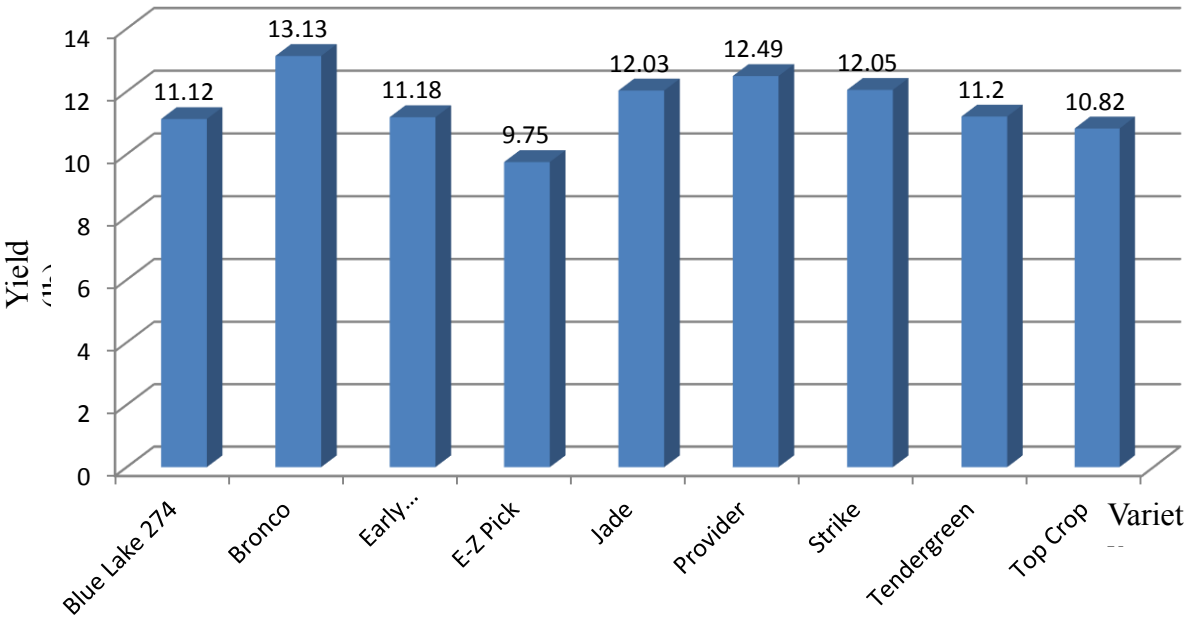


Fig.1. Yield of nine green snap bean cultivars evaluated in 2013 and 2014.

Table 3. Fruit quality of nine green snap bean cultivars evaluated in 2013 and 2014.

[z]Determination of flavor and appearance of green bean pods were made by 20 individual volunteers using a score of 1(low) to 5(high).

Cultivar	Avg. length of pods (inch)	Avg. diameter of pods (inch)	Texture[z]	Appearance[z]
1. Blue Lake 274	5.22 ± 0.42 ab	0.39 ± 0.03 ab	3.67 ± 0.67 ab	2.5 ± 0.3 c
2. Bronco	5.34 ± 0.27 ab	0.32 ± 0.03 bc	4.33 ± 0.67 ab	4.5 ± 0.3 a
3. Early Contender	4.96 ± 0.49 b	0.41 ± 0.05 a	2.33 ± 0.33 b	3.5 ± 0.5 abc
4. E-Z Pick	5.46 ± 0.50 ab	0.32 ± 0.02 bc	3.00 ± 1.00 ab	3.0 ± 0.7 bc
5. Jade	6.06 ± 0.76 a	0.33 ± 0.04 abc	4.67 ± 0.33 a	4.5 ± 0.3 a
6. Provider	5.20 ± 0.22 ab	0.36 ± 0.03 abc	3.33 ± 0.88 ab	4.0 ± 0.4 ab
7. Strike	4.84 ± 0.37 b	0.30 ± 0.03 c	3.33 ± 0.67 ab	4.5 ± 0.3 a
8. Tendergreen	5.14 ± 0.37 ab	0.34 ± 0.03 abc	3.33 ± 0.88 ab	3.5 ± 0.9 abc
9. Top Crop	5.30 ± 0.23 ab	0.36 ± 0.01 abc	2.33± 0.67 b	3.3 ± 0.6 abc
$LSD_{0.05}$[y]	*0.94*	*0.08*	*2.09*	*1.4*

Carrot

Table 1. Carrot cultivars evaluated in 2013 and 2014.

Cultivar	Seed source
1. Atomic Red	Fedco Seeds

2. Red Cored Chantenay	High Mowing
3. Chantenay Royal	Reimers
4. Scarlet Nantes	High Mowing
5. Danvers 126	High Mowing
6. Shin Kuroda	Fedco Seeds
7. YaYa F1	High Mowing
8. Napoli F1	High Mowing
9. Sugarsnax F1	Fedco Seeds
10. Negovia F1	Johnny's Selected Seeds

Table 2. Yield of ten carrot cultivars evaluated in 2013 and 2014.

Cultivar	Number of roots[z]	Weight of roots (lb)[y]	Number of marketable roots[x]	Weight of marketable roots (lb)[w]	% Avg. yield
1. Atomic Red	154.5 ± 17.7 abc	22.55 ± 3.07 c	99.9 ± 27.9 bc	13.04 ± 2.83 e	51.53 ± 6.22 b
2. Red Cored Chantenay	155.4 ± 29.3 abc	34.77 ± 5.94 ab	122.5 ± 33.5 abc	27.44 ± 4.67 a	110.42 ± 13.09 ab
3. Chantenay Royal	180.9 ± 33.5 abc	32.4 ± 4.93 ab	134.1 ± 41.7 abc	22.87 ± 4.29 abcd	94.33 ± 15.81 b
4. Scarlet Nantes	202.7 ± 48.7 ab	33.90 ± 6.39 ab	153.1 ± 41.1 ab	24.24 ± 4.84 abc	96.15 ± 13.92 b
5. Danvers 126	151.7 ± 24.9 bc	35.37 ± 5.71 a	101.4 ± 23.1 bc	24.82 ± 3.76 ab	106.23 ± 14.94 b
6. Shin Kuroda	123.2 ± 29.4 c	30.27 ± 5.96 ab	84.1 ± 24.3 c	17.04 ± 2.47 de	74.45 ± 11.67 b
7. YaYa F1	152.5 ± 19.9 bc	30.33 ± 5.18 ab	106.6 ± 18.6 bc	20.88 ± 3.42 bcd	85.89 ± 9.31 b
8. Napoli F1	158.9 ± 21.1 abc	35.20 ± 6.27 ab	107.3 ± 15.4 bc	23.57 ± 2.73 abc	107.84 ± 17.89 b
9. Sugarsnax F1	206.9 ± 38.2 ab	28.71 ± 4.57 bc	150.9 ± 38.4 ab	18.23 ± 2.53 cde	75.72 ± 10.87 b
10. Negovia F1	212.8 ± 32.4 a	31.89 ± 4.56 ab	174.6 ± 33.9 a	25.79 ± 3.85 ab	197.41 ± 82.83 a
$LSD_{0.05}$[y]	*60.2*	*6.64*	*57.7*	*6.39*	*87.02*

[z]Average number of carrots harvested from 10-foot row.
[y]Average weight of carrots harvested from 10-foot row.
[x]Average number of marketable carrots harvested from 10-foot row.
[w]Average weight of marketable carrots harvested from 10-foot row.

Variety

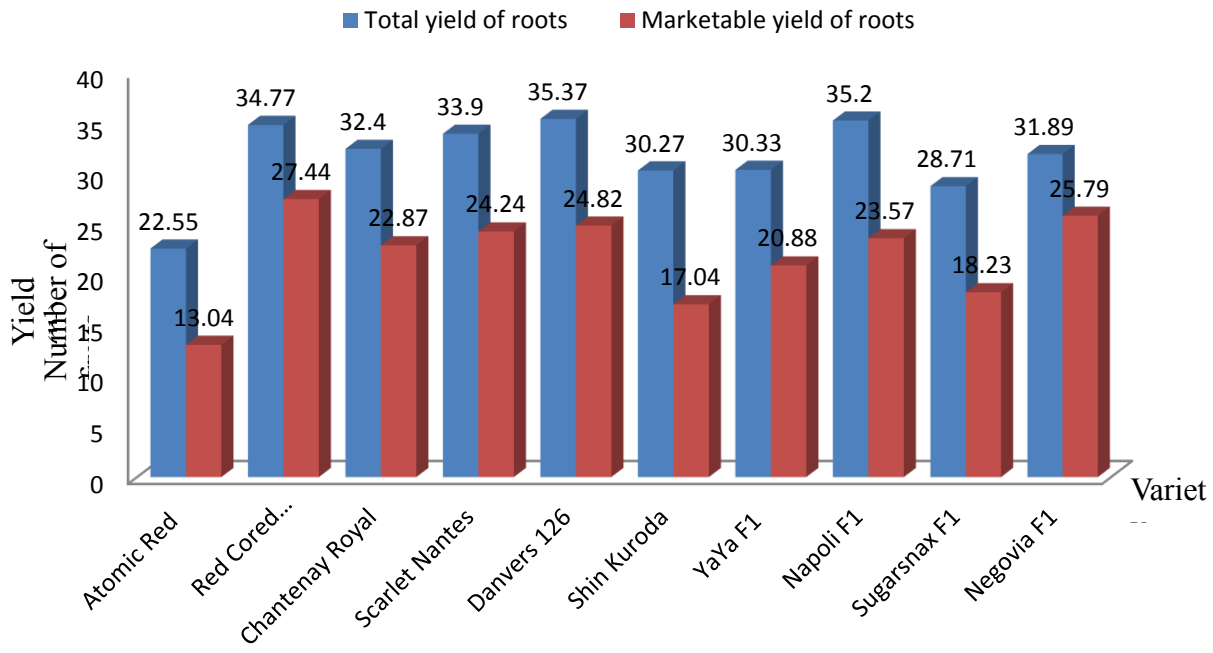


Fig.1. Yield of ten carrot cultivars evaluated in 2013 and 2014.

Table 3. Root quality of ten carrot cultivars evaluated in 2013 and 2014.

[z]Determination of flavor of carrot roots were made by 20 individual volunteers using a score of 1(low) to 5(high).

Cultivar	Avg. roots weight (lb)	Avg. length of roots (inch)	Avg. diameter of roots (inch)	Flavor[z]	Sugar (%)	
					Cortex (tissue skin)	Core (stem xylem)
1. Atomic Red	0.12 ± 0.02 de	6.41 ± 0.45 b	1.21 ± 0.06 de	2.56 ± 0.18 c	11.18 ± 0.50 bc	11.18 ± 0.39 a
2. Red Cored Chantenay	0.21 ± 0.04 bc	4.93 ± 0.35 d	1.74 ± 0.07 a	3.22 ± 0.28 bc	10.23 ± 0.44 cde	8.50 ± 0.43 def
3. Chantenay Royal	0.31 ± 0.03 a	5.19 ± 0.22 cd	1.74 ± 0.14 a	3.56 ± 0.34 ab	11.90 ± 0.48 ab	10.30 ± 0.56 abc
4. Scarlet Nantes	0.19 ± 0.02 c	5.66 ± 0.44 bcd	1.29 ± 0.08 d	3.78 ± 0.28 ab	9.95 ± 0.34 de	8.35 ± 0.47 ef
5. Danvers 126	0.19 ± 0.02 c	5.58 ± 0.39 bcd	1.48 ± 0.10 bc	4.22 ± 0.36 a	10.85 ± 0.32 bcd	8.98 ± 0.11 de
6. Shin Kuroda	0.18 ± 0.01 c	5.90 ± 0.29 bcd	1.50 ± 0.07 b	3.11 ± 0.20 bc	9.90 ± 0.54 de	9.28 ± 0.58 cde
7. YaYa F1	0.20 ± 0.02 c	5.97 ± 0.35 bc	1.27 ± 0.06 d	3.56 ± 0.41 ab	10.68 ± 0.45 cde	9.68 ± 0.37 bcd
8. Napoli F1	0.27 ± 0.02 ab	6.53 ± 042 b	1.32 ± 0.04 cd	3.33 ± 0.41 b	9.63 ± 0.33 e	7.60 ± 0.33 f
9. Sugarsnax F1	0.09 ± 0.01 e	7.91 ± 1.03 a	1.07 ± 0.06 e	3.78 ± 0.22 ab	12.92 ± 0.40 a	11.42 ± 0.54 a
10. Negovia F1	0.18 ± 0.02 cd	5.72 ± 0.35 bcd	1.29 ± 0.06 d	3.67 ± 0.17 ab	12.45 ± 0.37 a	10.83 ± 0.63 ab
$LSD_{0.05}$[y]	*0.06*	*1.00*	*0.17*	*0.73*	*1.19*	*1.27*

Cucumber

Table 1. Cucumber cultivars evaluated in 2013 and 2014.

Cultivar	Seed source
1. Bushy	SSE (Seed Savers Exchange)
2. A&C pickling	SSE
3. Parade	SSE
4. Double Yield	SSE
5. Russian Pickling	SSE
6. Marketmore 76	High Mowing
7. National Pickling	High Mowing
8. Marketmore 97	Territorial Seed Co.
9. Straight 8	Veseys
10. Eureka F1	Jung Seed Co. only non-organic seeds

Table 2. Yield of ten cucumber cultivars evaluated in 2013 and 2014.

Cultivar	Number of fruits[z]	Weight of fruits (lb)[y]	Number of marketable fruits[x]	Weight of marketable fruit (lb)[w]	% Avg. yield
1. Bushy	83.1 ± 38.1 a	24.03 ± 4.56 ab	72.0 ± 45.5 a	16.72 ± 4.91 a	104.67 ± 20.53 ab
2. A&C pickling	80.8 ± 18.5 ab	25.53 ± 9.02 a	70.9 ± 24.0 a	20.18 ± 9.59 a	105.83 ± 10.29 ab
3. Parade	54.2 ± 12.7 ab	22.79 ± 7.24 ab	39.2 ± 11.9 a	18.32 ± 9.17 a	99.79 ± 15.92 ab
4. Double Yield	77.7 ± 32.9 ab	21.17 ± 4.49 ab	69.57 ± 40.3 a	20.29 ± 5.84 a	123.99 ± 14.27 a
5. Russian Pickling	47.8 ± 8.8 ab	16.49 ± 5.17 b	38.7 ± 9.7 a	13.36 ± 6.69 a	72.36 ± 10.80 b
6. Marketmore 76	46.9 ± 13.5 ab	27.30 ± 9.02 a	30.7 ± 11.6 a	22.83 ± 12.62 a	103.71 ± 16.67 ab
7. National Pickling	72.9 ± 25.3 ab	19.48 ± 4.99 ab	61.6 ± 30.9 a	16.56 ± 5.68 a	96.95 ± 9.67 ab
8. Marketmore 97	45.0 ± 16.3 ab	23.41 ± 8.91 ab	26.1 ± 11.4 a	18.37 ± 11.34 a	87.46 ± 25.15 ab
9. Straight 8	32.8 ± 5.7 b	22.69 ± 5.87 ab	26.5 ± 4.5 a	17.17 ± 6.35 a	93.40 ± 9.66 ab
10. Eureka F1	71.3 ± 20.2 ab	23.67 ± 6.22 ab	59.3 ± 26.4 a	20.17 ± 7.43 a	111.63 ± 7.51 ab
$LSD_{0.05}$[y]	49.6	8.69	57.5	10.83	45.93

[z]Average number of fruits harvested from 5-plant row.
[y]Average weight of fruits harvested from 5- plant row.
[x]Average number of marketable fruits harvested from 5- plant row.
[w]Average weight of marketable fruits harvested from 5- plant row.

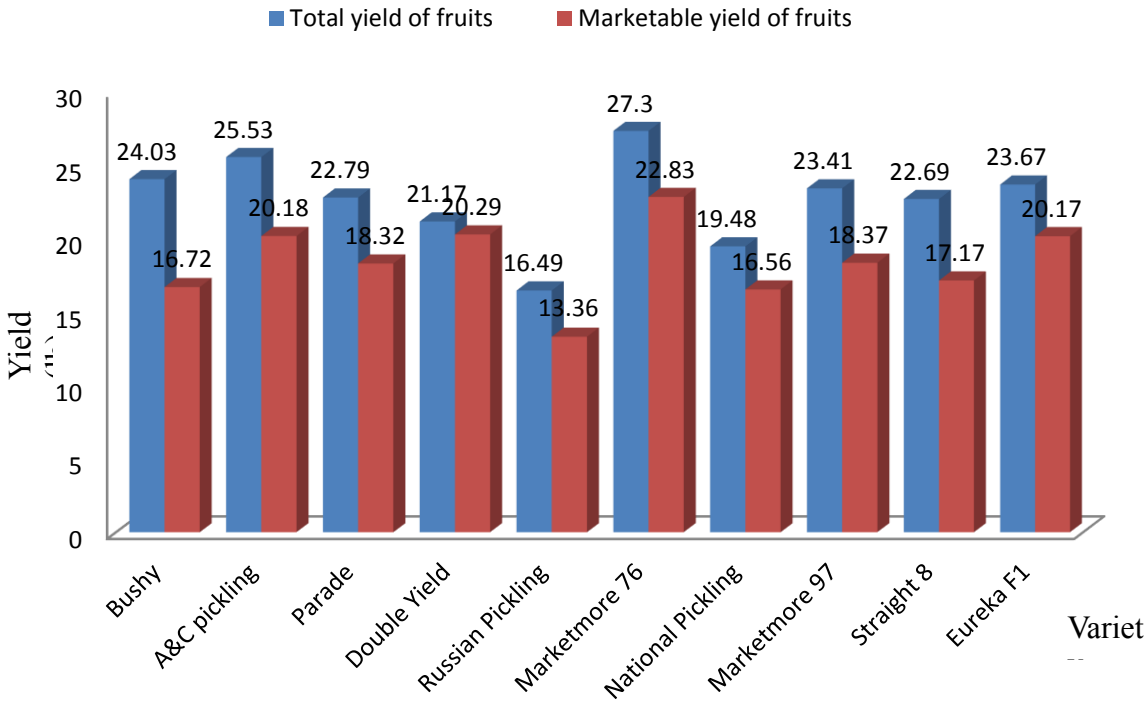


Fig. 1. Yield of ten cucumber cultivars evaluated in 2013 and 2014.

Table 3. Fruit quality of ten cucumber cultivars evaluated in 2013 and 2014.

Cultivar	Avg. fruit weight (lb)	Avg. length of fruits (inch)	Avg. width of fruits (inch)	Flavor[z]	Sugar (%)	
					Flesh	Core
1. Bushy	0.65 ± 0.05 c	5.86 ± 0.52 b	2.31 ± 0.26 abc	2.67 ± 0.41 ab	3.50 ± 0.11 bc[z]	3.63 ± 0.16 bc
2. A&C pickling	0.81 ± 0.03 b	6.01 ± 0.84 b	1.97 ± 0.37 bc	2.78 ± 0.32 ab	3.35 ± 0.22 bc	3.21 ± 0.15 d
3. Parade	0.62 ± 0.06 c	5.22 ± 0.49 b	2.09 ± 0.22 abc	2.89 ± 0.42 ab	3.63 ± 0.19 ab	4.17 ± 0.12 a
4. Double Yield	0.66 ± 0.06 c	5.37 ± 0.92 b	2.16 ± 0.39 abc	2.67 ± 0.29 ab	3.43 ± 0.08 bc	3.85 ± 0.23 abc
5. Russian Pickling	0.58 ± 0.08 c	5.01 ± 0.45 b	1.89 ± 0.21 c	2.56 ± 0.29 ab	3.45 ± 0.03 bc	4.05 ± 0.21 a
6. Marketmore 76	0.90 ± 0.01 ab	8.17 ± 0.42 a	2.55 ± 0.18 ab	3.00 ± 0.47 a	3.95 ± 0.15 a	3.91 ± 0.16 ab
7. National Pickling	0.66 ± 0.06 c	4.80 ± 0.57 b	1.88 ± 0.27 c	2.67 ± 0.33 ab	3.35 ± 0.06 bc	3.55 ± 0.11 bcd
8. Marketmore 97	0.87 ± 0.03 ab	8.33 ± 0.76 a	2.58 ± 0.23 ab	3.11 ± 0.35 a	3.53 ± 0.11 bc	3.86 ± 0.14 abc
9. Straight 8	0.92 ± 0.07 a	7.98 ± 0.44 a	2.69 ± 0.19 a	2.11 ± 0.39 b	3.50 ± 0.11 bc	3.91 ± 0.19 ab
10. Eureka F1	0.64 ± 0.08 c	5.93 ± 0.79 b	2.33 ± 0.33 abc	2.56 ± 0.41 ab	3.15 ± 0.06 c	3.47 ± 0.11 cd
$LSD_{0.05}$[y]	*0.09*	*1.49*	*0.64*	*0.85*	*0.38*	*0.41*

[z]Determination of flavor of cucumber fruit were made by 20 individual volunteers using a score of 1(low) to 5(high).

Pepper

Table 1. Pepper cultivars evaluated in 2014.

Cultivar	Seed source
1. King of the North	High Mowing
2. King Crimson F1	High Mowing
3. Jupiter	High Mowing
4. California Wonder	High Mowing
5. Peacework	Fedco Seeds
6. Carmen F1	Jung's Seed Co.
7. Yankee Bell	Johnny's Selected Seeds
8. Ruby King	SSE (Seed Savers Exchange)
9. Ace F1	Johnny's Selected Seeds
10. King Arthur F1	Jung's Seed Co.

Table 2. Yield of ten pepper cultivars evaluated in 2014.

Cultivar	Number of fruits[z]	Weight of fruits (lb)[y]	Number of marketable fruits[x]	Weight of marketable fruit (lb)[w]	% Avg. yield
1. King of the North	30.0 ± 18.6 bc	10.60 ± 4.78 b	28.2 ± 16.9 bc	10.05 ± 4.46 b	85.63 ± 27.26 b
2. King Crimson F1	32.1 ± 16.6 bc	11.76 ± 4.04 ab	30.2 ± 15.3 bc	10.49 ± 4.70 ab	91.63 ± 40.34 b
3. Jupiter	27.6 ± 14.6 bc	8.96 ± 4.29 b	24.8 ± 11.9 bc	8.26 ± 3.60 b	77.69 ± 20.97 b
4. California Wonder	17.8 ± 13.5 c	8.96 ± 3.29 b	15.9 ± 11.7 c	7.65 ± 3.13 b	68.21 ± 14.01 b
5. Peacework	24.3 ± 15.4 bc	10.69 ± 2.04 ab	22.3 ± 13.5 bc	9.56 ± 2.11 b	93.17 ± 1.83 b
6. Carmen F1	72.9 ± 13.6 a	17.68 ± 3.75 a	69.5 ± 11.8 a	17.25 ± 3.85 a	178.39 ± 39.09 a
7. Yankee Bell	20.3 ± 10.7 c	6.81 ± 3.02 b	18.0 ± 8.5 c	6.24 ± 2.46 b	60.07 ± 15.11 b
8. Ruby King	34.1 ± 14.6 bc	11.25 ± 2.91 ab	30.3 ± 11.6 bc	10.34 ± 2.25 ab	108.29 ± 28.27 ab
9. Ace F1	47.7 ± 18.2 b	11.48 ± 3.68 ab	43.1 ± 15.0 b	10.66 ± 3.21 ab	98.86 ± 13.59 ab
10. King Arthur F1	32.0 ± 8.6 bc	13.32 ± 1.43 ab	29.8 ± 8.1 bc	12.68 ± 0.97 ab	138.79 ± 39.09 ab
$LSD_{0.05}$[y]	24.0	6.99	24.1	7.15	84.49

[z]Average number of fruits harvested from 10-plant row.
[y]Average weight of fruits harvested from 10- plant row.
[x]Average number of marketable fruits harvested from 10- plant row.
[w]Average weight of marketable fruits harvested from 10- plant row.

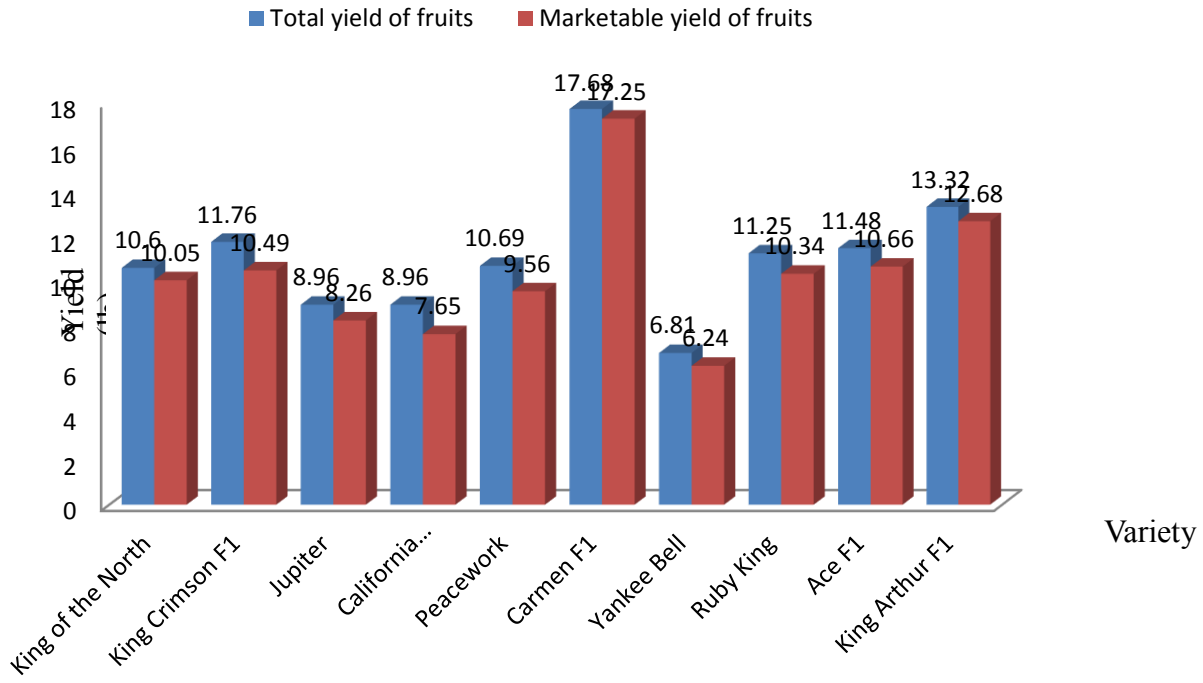


Fig. 1. Yield of ten pepper cultivars evaluated in 2014.

Table 3. Fruit quality of ten pepper cultivars evaluated in 2014.

Cultivar	Avg. fruit weight (lb)	Avg. length of fruits (inch)	Avg. width of Fruits (inch)	Flavor[z]	Avg. wall thickness (inch)	Sugar content (%)
1. King of the North	0.54 ± 0.04 abc	3.52 ± 0.89 bcd	2.59 ± 0.66 ab	3.17 ± 0.31 b	0.20 ± 0.06 ab	8.50± 0.09 ab
2. King Crimson F1	0.39 ± 0.04 def	3.12 ± 0.80 bcd	2.69 ± 0.69 ab	3.33 ± 0.21 ab	0.19 ± 0.05 ab	7.40 ± 0.20 ab
3. Jupiter	0.59 ± 0.01 ab	3.17 ± 0.82 bcd	2.90 ± 0.73 ab	3.33 ± 0.33 ab	0.23 ± 0.06 a	8.38 ± 0.39 ab
4. California Wonder	0.0.51 ± 0.01 bc	2.48 ± 1.02 cd	2.25 ± 0.92 ab	4.00 ± 0.37 ab	0.21 ± 0.08 ab	6.98 ± 0.60 b
5. Peacework	0.36 ± 0.03 efg	2.13 ± 0.87 d	1.89 ± 0.77 b	3.33 ± 0.49 ab	0.11 ± 0.04 b	8.70 ± 1.22 a
6. Carmen F1	0.25 ± 0.03 g	6.38 ± 0.40 a	2.34 ± 0.19 ab	4.17 ± 0.31 a	0.21 ± 0.03 ab	7.93 ± 0.68 ab
7. Yankee Bell	0.49 ± 0.04 bcd	2.93 ± 0.76 bcd	2.62 ± 0.66 ab	3.33 ± 0.33 ab	0.19 ± 0.05 ab	8.35 ± 0.26 ab
8. Ruby King	0.43 ± 0.04 cde	4.33 ± 0.42 bc	3.61 ± 0.40 a	3.17 ± 0.31 b	0.23 ± 0.02 a	8.78 ± 0.48 a
9. Ace F1	0.29 ± 0.02 fg	4.66 ± 0.65 ab	2.74 ± 0.11 ab	3.83 ± 0.17 ab	0.19 ± 0.01 ab	8.38 ± 0.65 ab
10. King Arthur F1	0.65 ± 0.08 a	3.45 ± 0.92 bcd	2.99 ± 0.76 ab	3.17 ± 0.31 b	0.26 ± 0.07 a	7.68 ± 0.11 ab
$LSD_{0.05}$[y]	*0.12*	*1.87*	*1.53*	*0.90*	*0.11*	*1.63*

[z]Determination of flavor of pepper fruit were made by 20 individual volunteers using a score of 1(low) to 5(high).

Tomato

Table 1. Tomato cultivars evaluated in 2014.

Cultivar	Seed source
1. Moskvich	High Mowing
2. Cosmonaut Volkov	High Mowing
3. Rutgers	High Mowing
4. Lark	NDSU
5. Cannonball	NDSU
6. Sheyenne	NDSU
7. Early Girl F1	Jung's Seed Co.
8. Jung's Wayahead	Jung's Seed Co.
9. John Baer	SSE (Seed Savers Exchange)
10. Oregon Spring	Johnny's Selected Seeds

Table 2. Yield of ten tomato cultivars evaluated in 2014.

Cultivar	Number of fruits[z]	Weight of fruits (lb)[y]	Number of marketable fruits[x]	Weight of marketable fruit (lb)[w]	% Avg. yield
1. Moskvich	201.3 ± 89.1 bc	56.07 ± 18.85 abc	169.9 ± 69.6 b	49.81 ± 16.64 abc	91.38 ± 9.19 ab
2. Cosmonaut Volkov	243.8 ± 113.5 abc	73.49 ± 26.43 a	213.1 ± 105.4 ab	66.66 ± 24.60 a	121.51 ± 16.04 a
3. Rutgers	288.0 ± 134.5 ab	64.74 ± 18.64 ab	256.6 ± 118.7 ab	60.35 ± 16.86 ab	123.85 ± 12.56 a
4. Lark	148.3 ± 47.4 c	26.80 ± 8.39 c	125.8 ± 37.3 b	22.14 ± 6.18 c	59.33 ± 26.74 b
5. Cannonball	187.3 ± 82.9 bc	79.11 ± 24.24 a	153.4 ± 69.1 b	69.05 ± 21.51 a	132.79 ± 6.46 a
6. Sheyenne	231.5 ± 99.1 bc	65.45 ± 19.47 ab	199.3 ± 80.0 b	57.33 ± 17.19 ab	116.67 ± 12.01 a
7. Early Girl F1	188.8 ± 103.8 bc	39.90 ± 22.85 bc	165.5 ± 86.3 b	37.41 ± 20.95 bc	54.88 ± 21.33 b
8. Jung's Wayahead	369.8 ± 175.5 a	78.67 ± 36.64 a	332.7 ± 156.5 a	72.22 ± 32.51 a	119.35 ± 26.10 a
9. John Baer	218.8 ± 102.2 bc	54.69 ± 20.69 abc	184.6 ± 79.5 b	48.98 ± 18.39 abc	86.45 ± 6.18 ab
10. Oregon Spring	182.8 ± 66.9 bc	51.46 ± 16.18 abc	162.5 ± 58.3 b	47.24 ± 14.08 abc	93.79 ± 11.22 ab
$LSD_{0.05}$[y]	138.0	30.44	131.6	28.91	50.26

[z]Average number of fruits harvested from 10-plant row.
[y]Average weight of fruits harvested from 10- plant row.
[x]Average number of marketable fruits harvested from 10- plant row.
[w]Average weight of marketable fruits harvested from 10- plant row.

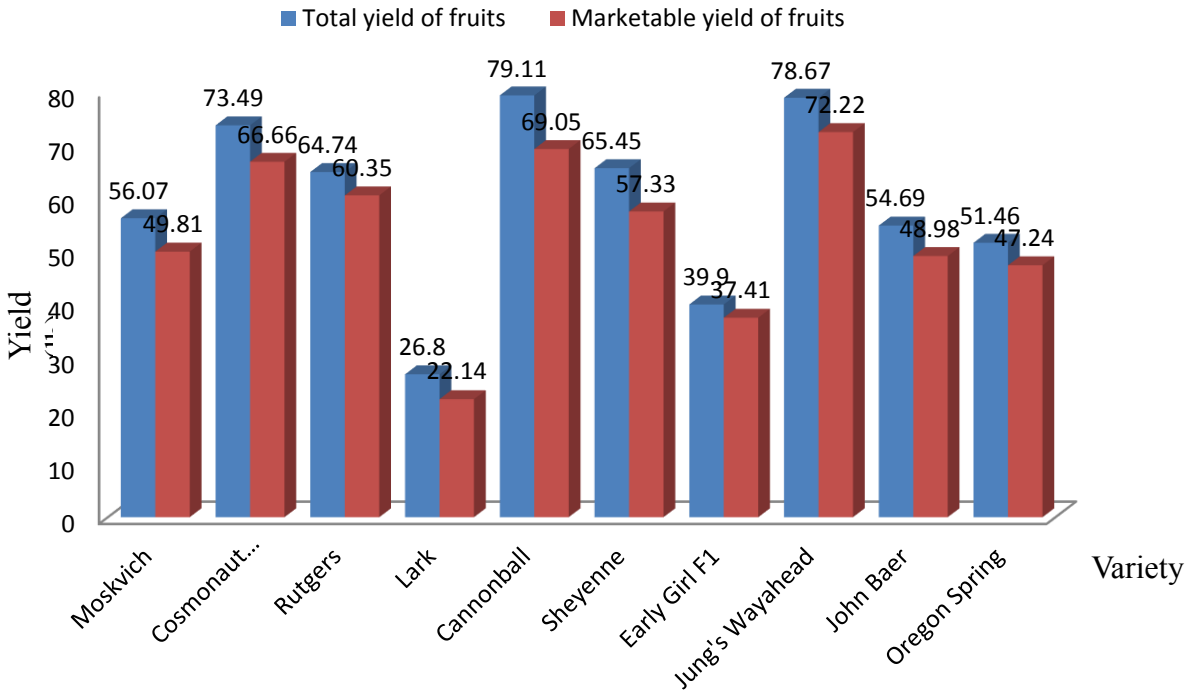
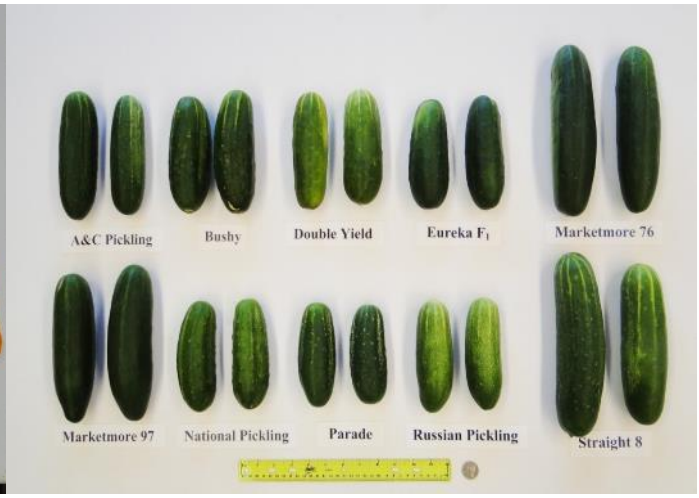


Fig. 1. Yield of ten tomato cultivars evaluated in 2014.

Table 3. Fruit quality of ten tomato cultivars evaluated in 2014.

Cultivar	Avg. fruit weight (lb)	Avg. length of fruits (inch)	Avg. width of fruits (inch)	Flavor[z]	Sugar (%)	
					Blossom End	Locule
1. Moskvich	0.23 ± 0.01 b	2.08 ± 0.15 a	2.34 ± 0.12 a	2.75 ± 0.25 b	6.78± 0.19 a	6.33 ± 0.22 a
2. Cosmonaut Volkov	0.32 ± 0.02 a	1.92 ± 0.18 abc	2.26 ± 0.38 a	4.00 ± 0.41 a	6.65 ± 0.11 a	6.49 ± 0.13 a
3. Rutgers	0.17 ± 0.01 c	1.60 ± 0.22 cd	1.56 ± 0.18 d	3.00 ± 0.41 ab	5.46 ± 0.24 c	5.26 ± 0.27 c
4. Lark	0.22 ± 0.01 bc	1.74 ± 0.19 abcd	1.72 ± 0.07 bcd	3.25 ± 0.25 ab	5.21 ± 0.29 cd	5.13 ± 0.32 cd
5. Cannonball	0.35 ± 0.04 a	2.16 ± 0.11 a	2.10 ± 0.12 abc	3.25 ± 0.25 ab	5.55 ± 0.16 c	5.20 ± 0.12 c
6. Sheyenne	0.26 ± 0.02 b	2.06 ± 0.17 ab	2.00 ± 0.14 abcd	3.00 ± 0.41 ab	4.66 ± 0.22 d	4.60 ± 0.23 d
7. Early Girl F1	0.22 ± 0.02 bc	1.64 ± 0.26 bcd	1.64 ± 0.26 cd	2.75 ± 0.25 b	6.31 ± 0.14 ab	6.03 ± 0.16 ab
8. Jung's Wayahead	0.27 ± 0.02 b	2.02 ± 0.12 abc	2.20 ± 0.21 ab	3.75 ± 0.48 ab	5.73 ± 0.18 bc	5.53 ± 0.18 bc
9. John Baer	0.24 ± 0.01 b	2.06 ± 0.24 ab	2.00 ± 0.25 abcd	3.50 ± 0.29 ab	6.65 ± 0.32 a	6.41 ± 0.29 a
10. Oregon Spring	0.26 ± 0.03 b	1.38 ± 0.29 d	1.68 ± 0.19 cd	3.25 ± 0.25 ab	5.46 ± 0.19c	5.39 ± 0.18 c
$LSD_{0.05}$[y]	*0.05*	*0.42*	*0.48*	*1.01*	*0.59*	*0.58*

[z]Determination of flavor of tomato fruit were made by 20 individual volunteers using a score of 1(low) to 5(high).



Harvests from
NDSU in 2014

Annie Carlson's July 2014 Field Day at Morning Joy Farm

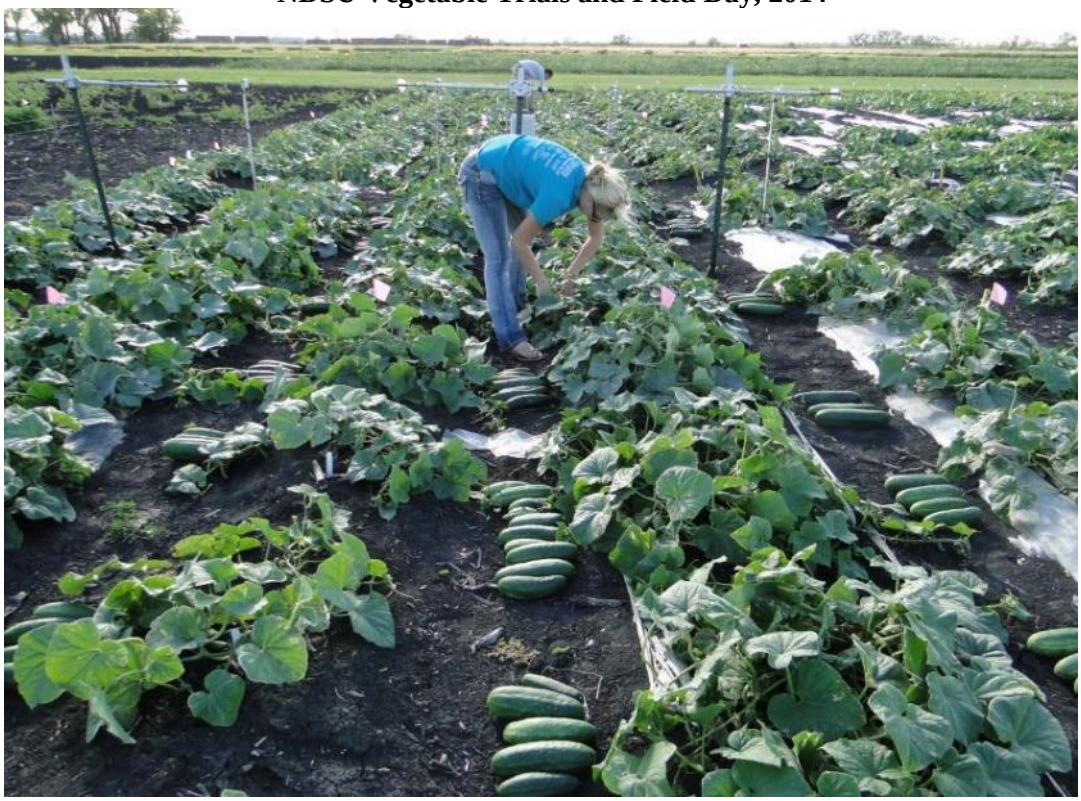
Marvin Baker conducts taste testing of some early tomatoes at North Star Farm in August 2014.

Tasting tomatoes at North Star Farm in August 2014.

Some of the plants at Hiddendale Farm were hit by spray drift causing the termination of the trial.

Marte Stensli weighs tomatoes harvested during her field day at Tangle Tree Ranch in August 2014.

NDSU Vegetable Trials and Field Day, 2014



Kelli Evans, undergraduate work study student, is harvesting cucumber fruits in the vegetable trial field plot

Cucumbers harvested, vegetable trials, September 5.2014

Vegetable trials field day, NDSU campus field plot, September 19, 2014

Vegetable trials field day, NDSU campus field plot, September 19, 2014

Some students in horticulture science class participated in the vegetable trials field day event, NDSU campus field plot, September 19, 2014

Vegetable trials field day, NDSU campus field plot, September 19, 2014

Pepper cultivar ‘Carmen’ shown at the center, top row had the most sweet taste.

Vegetable trials field day, NDSU campus field plot, September 19, 2014

Participants of the vegetable trials field day harvest carrots from the border rows, September 19, 2014.

Harvesting and tasting of freshly harvested vegetables by students in horticulture science lab, September 3, 2014.

Fruits of 10 tomato cultivars grown in the test plot in 2014.


Harvesting of carrots, October 14, 2014.